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A comparison of spot, transect and plot methods for measuring the impact of forest pest control strategies on forest songbirds

R.L. Millikin

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Forest Pest Management Institute

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CAPTION FOR FRONT COVER:

Censusing of forest songbirds using a gridded map to record the location and activity of each bird observed.

A COMPARISON OF SPOT, TRANSECT AND PLOT METHODS FOR MEASURING THE IMPACT OF FOREST PEST CONTROL STRATEGIES ON FOREST SONGBIRDS

by R.L. Millikin

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FOREST PEST MANAGEMENT INSTITUTE

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Cette publication est aussi disponible en français sous le titre Comparaison des méthodes par points, par transect et par placette pour mesurer l'impact des stratégies de lutte contre les insectes ravageurs des forêts sur les oiseaux chanteurs des forêts.

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ABSTRACT

Of the methods tested, the plot method would be most preferable to determine the effects of forest spraying on forest songbirds. Relative abundance and species diversity increased with a greater amount of time on the plot, and for the delineation of territories, transect and spot census methods were less precise. Multiple spot censuses, conducted within one day, were as accurate as the same number of censuses conducted over separate days. Three census methods (spot, transect, and plot) were compared, using territory mapping, on one 4 ha plot in 1979 at Wawa, Ontario. The timing of consecutive spot censuses was studied at Searchmont, Ontario, in 1980.

RÉSUMÉ

Parmi les méthodes expérimentées, la méthode par placette offre les meilleures possibilités pour déterminer les effets des pulvérisations sur les oiseaux chanteurs des forêts. L'abondance relative et la diversité des espèces augmentaient proportionnellement avec le temps dans le cas du recensement par placette, et la délimitation des territoires n'était pas aussi précise avec les méthodes de recensement par transect et par points. Des recensements multiples par points, faits le même jour, ont été aussi précis que le même nombre de recensements faits en des jours différents. Trois méthodes de recensement (par points, par transect et par placette) ont été comparées à l'aide du relevé cartographique du territoire, sur une placette de 4 ha en 1979, à Wawa (Ontario). L'échelonnement des recensements consécutifs par points a été étudié à Searchmont (Ontario) en 1980.

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INTRODUCTION

To develop a program to determine the effects of spraying on forest songbirds, existing breeding bird census techniques were modified. As most spray programs occur in late spring to early summer, the populations of breeding birds as well as nestlings and fledglings were monitored.

The territory mapping method developed by Kendeigh (1944), which measures the total population present during the breeding season, has been used as a monitoring tool to assess the impact of forest spraying (Kendeigh 1947). An impact is interpreted as: 1) a reduction in singing activity; 2) a loss of territory; and/or 3) a shift in territory locations. The number of breeding territories is assessed by mapping territory boundaries, indicated by the male's song and by interactions with other males. Kendeigh (1944) recognized the limitations in the use of singing males to indicate the number of nesting pairs; some individuals may be unmated, and males often reduce their singing after they acquire a mate and start nesting. However, he felt a singing male did represent a potential breeding pair.

In the initial stages of breeding bird census methodology (Kendeigh 1947, for example), plots were larger (8 ha) and more permanent than they are now. Operational sprays are, however, much larger than 8 ha, requiring modifications of census methods to cover a greater area. Plot sizes were therefore reduced to 4 ha, and the use of transects and 'spots' (single points) was explored as a means of increasing the area covered without taxing the available manpower or resources. An additional constraint may be adverse weather conditions. With a limited number of days available for censusing, an important option would be to compress censusing into fewer days. For this reason, we examined the possibility of delineating territories with five spot censuses on one day as apposed to one spot census over 5 days.

The objective of this study was to try these different census methods (plot, transect, and spot censuses) on one 4 ha plot, to compare the merits and uses of each. The plot method was used as a standard by which to compare all other methods. The basis of analysis was the number of territories recorded. All studies were conducted at Wawa, Ontario in 1979 except for the program involving consecutive spot censuses on one day, which was conducted at Searchmont, Ontario in 1980.

METHODS

Comparisons of the censuses were made within a single 4 ha plot (Fig. 1). In the plot method, the observer walked a marked route through the plot recording the position of all singing and sighted birds on a plot map. Coverage of the plot may be reduced from every line to every second line, depending on density of the vegetation and the ability of the observer. The transect method consisted of a single census line through the center of the plot. The spot method consisted of a stationary census point or spot in the exact center of the plot; the observer remained stationary, periodically turning to aid in orientation and definition of sounds. Examples of the plot maps are given in Appendix III.

Whenever possible, the center line of the census plot, and hence the transect, was situated along an old road or path. Flags were stationed every 40 m along this center-line and one at 140 m for the spot census. Lines were extended perpendicular to the center-line and stations were flagged, forming a 40 m square grid over the plot. Lines were cleared of small branches to facilitate safe and quiet passage while censusing. This increased efficiency of the census and reduced disturbance of the birds. Only birds inside the plot boundary were counted. This stipulation could not be met with the transect and spot methods, as an exact boundary could not be determined (every bird seen or heard was recorded).

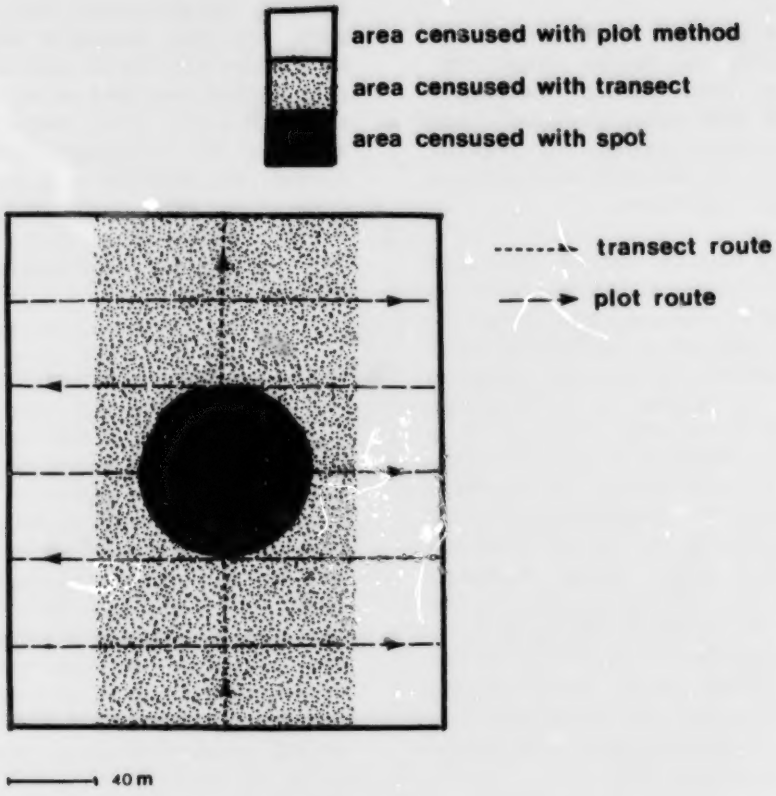

Figure 1. Extent of the census area using the different census methods.

Censuses were conducted daily during the first few hours of light, requiring 5-15 min for the spot, approximately 1/2 an hour for the transect, and an hour for the plot method. The census period was generally 5 days before to at least 5 days after the last application of the insecticide. The location of each bird (seen or heard) was recorded in relation to the flagged stations, using a fresh map sheet each day. Wherever possible, birds were identified by species, sex, and type of activity at the time of record (Table 1). Male birds vocally defending a territory were assumed to be mated and were therefore recorded as two birds; all others (non-singing, sighted, females or immatures) were recorded as one. Birds of the same species, exhibiting simultaneous vocal defense, were recorded with special symbols to denote territorial boundaries.

Daily maps were combined for each species over prespray then postspray time periods. These symbols, together with clusters of observations, were used to delineate territories, which were the basis for analysis of pesticide effects with all methods (plot, transect and spot). A territory was designated as an area vocally defended for a minimum of 2 days. Adjacent clusters of observations were recognized as two separate territories if there was a record of counter singing. However, where

Table 1. Symbols used to denote species, sex and type of activity at the time of record

(TE)	MALE of the species (singing)
TE♂	Male of the species (sighted)
TE	FEMALE of the species (singing or sighted)
(TE) TE	MATED PAIR
*	NEST
CRO	A crow, SEX UNDETERMINED
CRO⁴	4 crows, SEX UNDETERMINED
SS 4	A pair of song sparrows with 4 FLEDGLINGS
——BJ——→	blue jay, sex undetermined, FLYING IN DIRECTION OF ARROW
(V)	veery, a singing male, POSITION APPROXIMATE
(CHP)+(CHP)	2 male chipping sparrows in vocal defence of THEIR TERRITORIES, one singing after another.
RWB♂--- RWB♂	A male red-winged blackbird ASSUMED to have moved from one spot to another
RWB♂—— RWB♂	A male red-winged blackbird OBSERVED moving from one spot to another
(YW) X (YW) U₁	2 male yellow warblers in territorial BOUNDARY CONFLICT NUMBERS denote an unidentified bird,

no counter singing was recorded, but there were multiple records of a species in two different locations on the same day for at least 2 days, and the two locations were far enough apart to suggest separate territories, these were considered sufficient criteria to delineate the territories (such cases are noted). Each territory map includes both the number of days required to delineate the territories and the total number of days the bird was observed in territory (example Appendix III, Fig. 1).

Activity trends and relative abundance over the study period were determined from the number of birds observed during each census. The distance of audibility was defined as the distance each species could be detected. This was calculated from spot and transect territory maps, using the distance of each bird from the observer. Meteorological measurements including wind speed and direction, temperature, relative humidity, cloud cover, and precipitation, were taken daily to determine the effects of weather on songbird activity.

The usual organization of a monitoring program entails the censusing of two plots per person during the peak hours of bird activity (the first 2-3 hours of daylight). For this reason, two spot censuses ('early' and 'late') were conducted an average of 2 hours apart so that censuses would occur during the active period of the day, but be separated by a time interval equal to that normally used by one person during a monitoring program.

The possibility of delineating territories with replications of a spot census within a time constraint of one day was also examined to determine if territories could still be accurately placed, when logistics would not permit daily replications.

The population censused with the standard 4 ha plot method was assumed to be as accurate a determination of the bird community within that area as possible, and was therefore used as the standard. The number of birds censused with a 5, 10 and 15 minute spot census and with a transect were calculated as a proportion of this standard.

RESULTS AND DISCUSSION

Comparison of Spot and Transect Censuses to a Standard Plot Census:

The resources necessary for the plot census were decidedly more than both the transect and spot census methods (Table 2). The flagging of a plot required a minimum of two people, and a full afternoon to complete, and was more difficult to establish as a greater area of continuous bush is required. Both the number of birds and the number of species censused in each family showed a general increase with a more extensive census (Figs. 2 and 3).

Numbers of birds censused:

The proportion of birds censused with the plot method compared to the spot and transect methods did not follow a consistent pattern. The expected trend of higher proportions with an increased length of time spent in the plot, was not found with all families of birds (Table 3). Higher percentages of Turdidae, Sylviidae and Fringillidae were recorded in the 5 min census than in other spot censuses. As all three spot censuses were conducted simultaneously, it is peculiar that more birds were recorded in a shorter time. Apparently, under the pressure of a restricted time frame the observer recorded more of the common, more easily identifiable species at the expense of other more difficult or infrequent singers. Species of Turdidae, Sylviidae (ruby-crowned kinglet) and Fringillidae are loud and easily identified and therefore easier to record in a situation when time is of the essence. Species of Parulidae, and to a lesser extent Vireonidae, were not censused extensively with a 5 min spot. Most species in these families tend to be more difficult to identify and more difficult to hear, either due to the infrequency of their singing or the inconspicuousness of their song. When comparing the average number of species of these more difficult families (Fig. 2), it

Table 2. Resources necessary for each census method

	Time required for preparation	Time required for census	Number of people needed
Plot	4 hours	1 hour	minimum of 2
Transect	20 min	½ hour	1
Spot	5 min	5, 10, 15 min	1

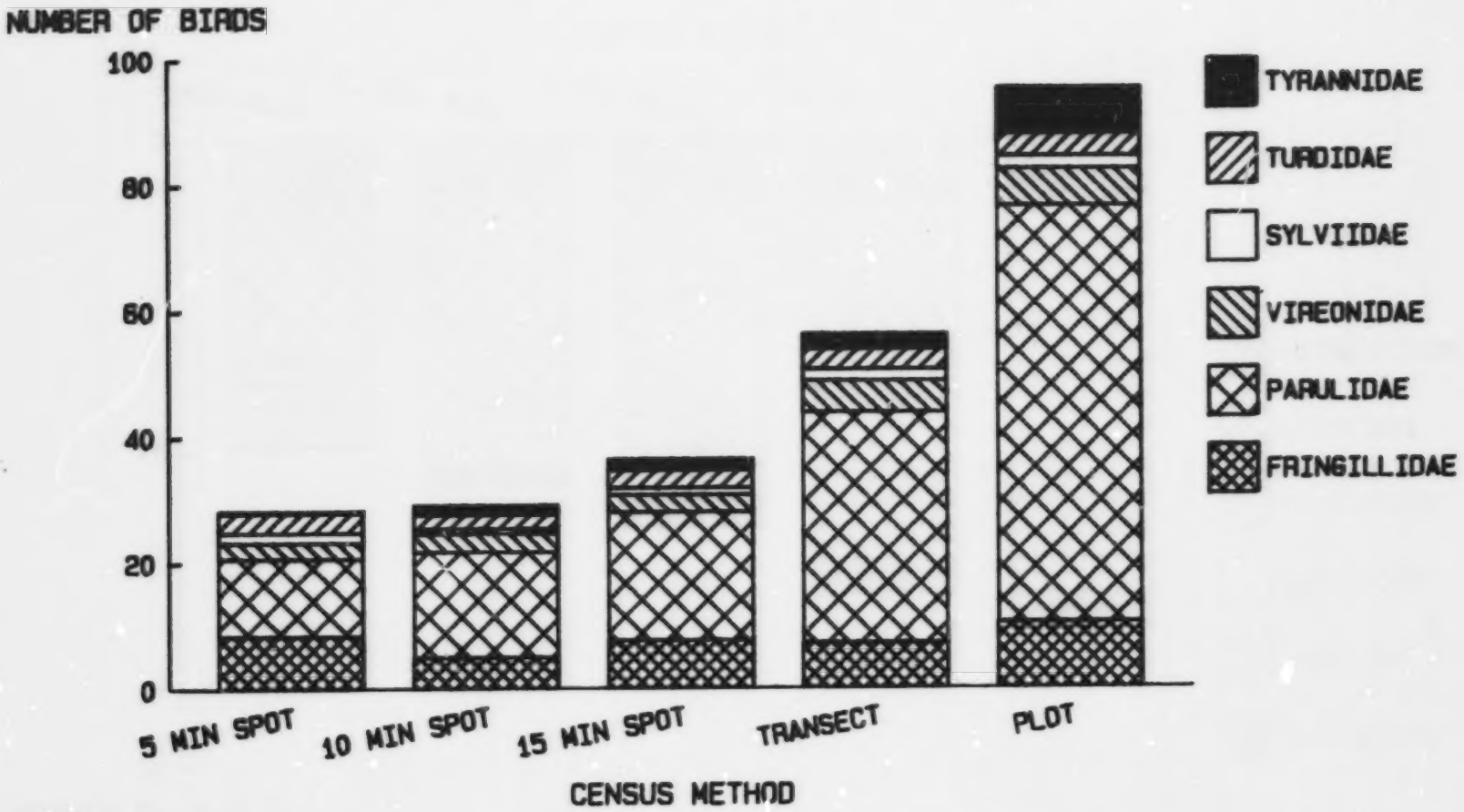

Figure 2. Comparison of the number of birds censused using different census methods.

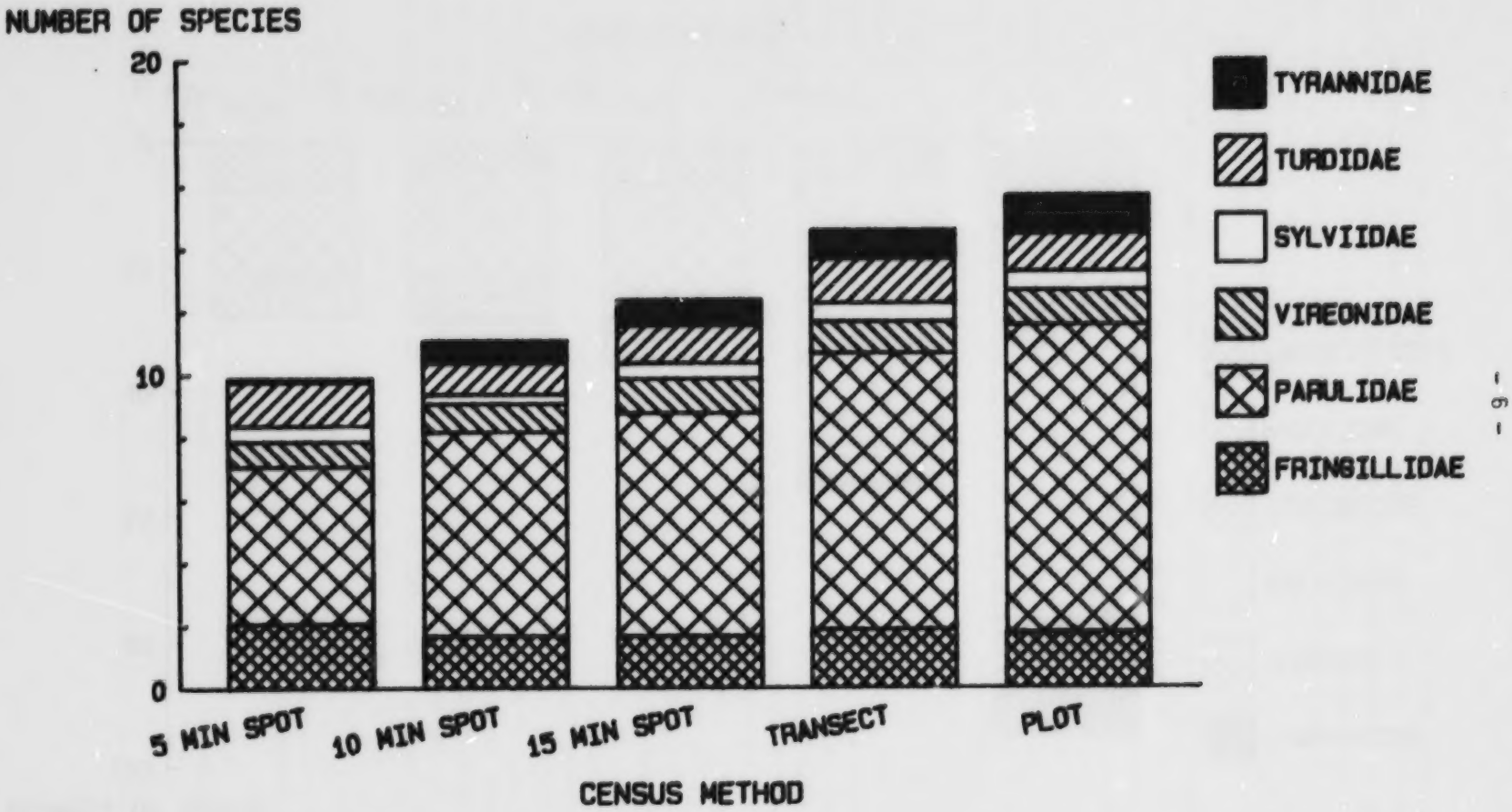

Figure 3. Comparison of the number of species censused using different census methods.

Table 3. Proportion[a] of the bird community on a 4 ha plot, that was censused with a 5, 10 and 15 minute spot census and with a transect, Wawa, Ontario, 4-16 June 1979

Method	5[b] min	10[b] min	15[b] min	Transect
Family				
Tyrannidae	4.1[c]	20.5	24.7	32.8
Turdidae	86.1	61.1	77.8	88.9
Sylviidae	80.0	40.0	55.0	90.0
Vireonidae	42.4	49.2	45.8	84.7
Parulidae	18.8	25.3	30.9	55.4
Fringillidae	80.2	49.1	73.6	69.8
Total birds	28.8	30.8	39.2	59.2

[a]numbers are given as a percent of the number obtained with a standard 4 ha plot census.
[b]average of 'early' and 'late' censuses
[c]avg of all censuses from 4-16 June (excluding 15 June from the early spot censuses due to poor weather conditions)

is apparent that the observer was able to distinguish a greater number of species when given a longer time period to census.

Efficiency decreased with an increase in census time (Table 4). Average efficiency rates (expressed as the number of birds per census minute) for the 10 and 15 min spot and transect censuses were similar, and greater than that of the plot census. The 5 min spot was more efficient than any of the other methods.

Daily fluctuations in the number of birds censused were greater with the plot (CV = 29%, Fig. 4), than with spot or transect methods. Fluctuations could not be correlated with weather data as censuses were not conducted in adverse weather conditions (rain or drizzle) and sensitive weather equipment was not available. High winds (16-32 kph) on 14 June did, however, correspond to a lower number of birds for all census methods.

Table 4. Number of birds[a] per minute using three different census techniques to determine which method is most efficient. Wawa, Ontario 4-16 June, 1979

		Census Method				
		Point Census			Transect	Plot
Date		5 min	10 min	15 min		
June	4	6.1[b]	3.1	2.6	1.8	2.1
	5	5.8	3.1	3.3	1.8	1.5
	6	4.2	3.3	2.8	1.8	1.2
	7	3.8	3.1	2.6	4.8	1.7
	8	5.3	3.4	2.7	1.7	1.3
	9	5.6	3.6	3.1	2.5	1.3
	11	6.2	2.4	2.3	2.4	1.4
	12	6.3	3.1	2.8	2.1	1.2
	14	5.8	2.4	1.9	0.7	1.7
	16	7.6	2.9	3.0	2.9	1.6
	Avg	5.7	3.0	2.7	2.3	1.5

[a]selected species only
[b]expressed as number of birds÷length of census

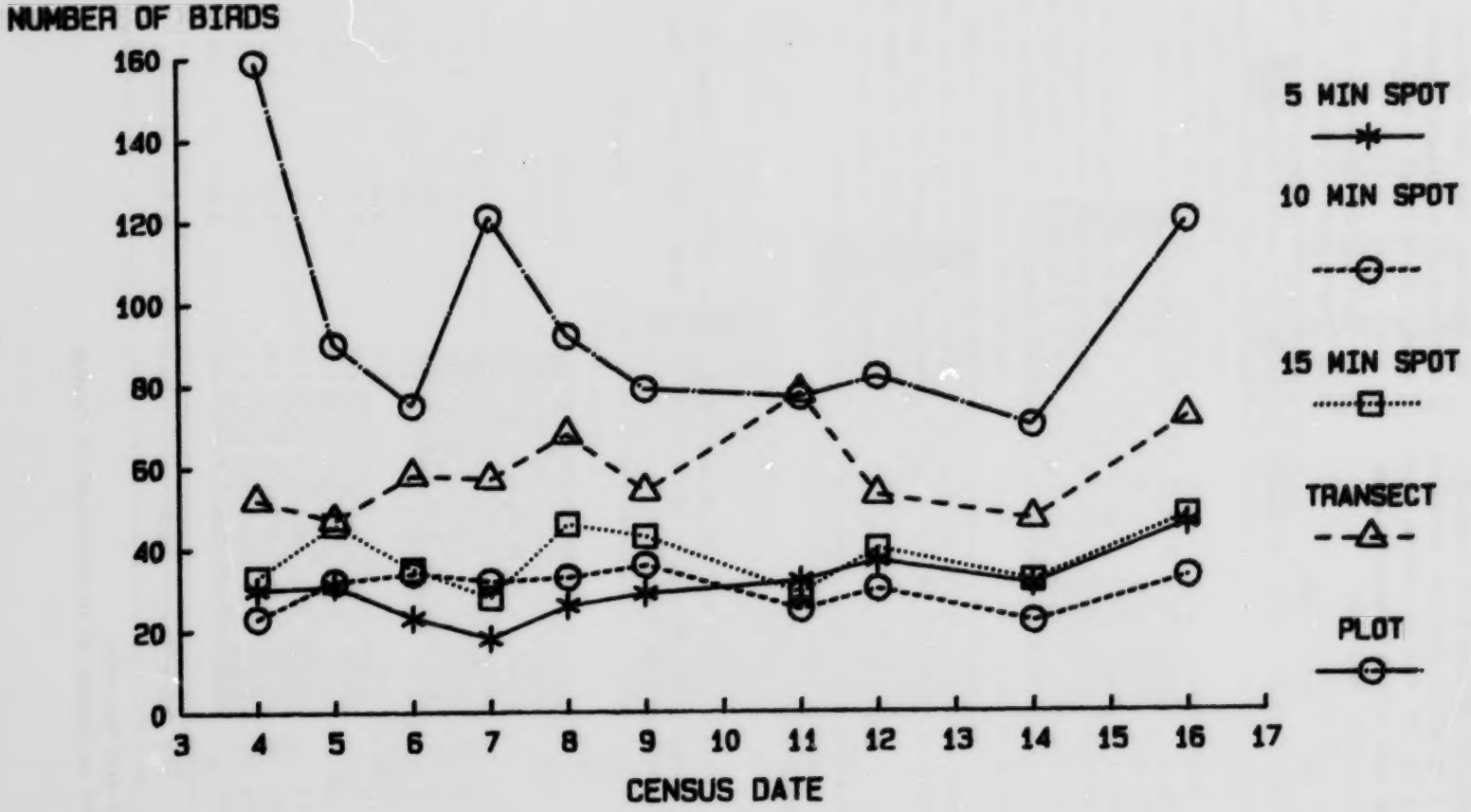

Figure 4. Daily fluctuations in census results using different census methods.

Species censused:

During the course of the experiments, a listing was made of bird species in the vicinity of the plots. Not all of these species were recorded during the censuses. Species known to be in the area, but not recorded during each census method, are listed in Table 5.

To adequately monitor a forest bird community for environmental impact it is not necessary to catalogue the entire population. Instead, indicator species may (and should) be chosen to illustrate trends in the overall community. Of the birds well documented with all three methods, the least flycatcher, ruby-crowned kinglet, tennessee warbler, yellow-rumped warbler,

Table 5. Species not recorded

Census Method	Species
5 min spot	RV[a], F, YBS, EPH, YBF, GJ, BCC, BRC, W, CAT, BT, MA, MO, CA, P1G, RU, PHU, CHP.
10 min spot	RV, EPH, YBF, GT, BJ, BCC, BRC.
15 min spot	RV, EPH, YBF, BJ, BRC, CAT, SV.
Transect	YBF, GJ, BT, CM, J.
Plot	EPH, BRC, BT, J.

[a]See Appendix I for a list of bird names and their short forms.

american redstart and purple finch, have all been discussed in terms of their high exposure to aerial treatments (for example, Pearce 1968; Buckner 1974; Peakall and Bart 1983).

Most species not recorded would be of little value in the analysis of pesticide effects because of their large territories or the infrequency of territorial defence. This is especially apparent when considering species recorded with all but the plot method. The ruffed grouse, yellow-bellied sapsucker, gray jay, blue jay, black-capped chickadee, and pine grosbeak all have large territories and may only move into the plot area during scattered times of the day: too infrequently to be consistently censused with the spot method, and in the case of the gray jay, with the transect method. The yellow-bellied sapsucker, pine grosbeak, and black-capped chickadee were recorded only with a longer spot census. The canada warbler, brown thrasher, eastern phoebe and catbird sang too infrequently to be detected within a restricted census period. The songs of these species are not particularly difficult to identify.

Species difficult to identify, due to the similarity of their song to other species (for example, the vireos, the chipping sparrow and dark-eyed junco), presented problems in the spot censuses (Appendix II, Tables 1-6). However, in the transect and plot methods (Appendix II, Tables 7-8) these problems were overcome as the observer was able to locate the bird in question and verify its identification. With all vireo species the transect method was

adequate for delineating territories, but there were problems in delineation using the spot methods (Appendix III, Fig. 19).

Typically distinctive songs such as those of the ruby-crowned kinglet, black-throated green warbler, ovenbird and white-throated sparrow, can be immediately identified. Other species not as common may have to be heard a few times before the observer is confident in their identification, or may not be recognized at all. All four species mentioned above were adequately censused with a 5 min spot (average of 80, 56, 82 and 82% respectively of the number recorded with a plot census (Table 6)). However, the black-throated green warbler may not sing regularly enough for the delineation of territories by counter singing (Appendix III, Fig. 10). Territories of the white-throated sparrow corresponded well with those determined by the plot method for the 5 min spot, but not for the other spots or transect (Appendix III, Fig. 18). Again this may be a reflection of the concentration on more common species under a time restriction. In the other censuses the observers were undoubtedly concentrating on other species, therefore less conscious of white-throated sparrows.

The magnolia and mourning warblers, although they have fairly distinctive songs, were not recorded during the 5 min spot censuses (Table 6). As the mourning warbler is uncommon and sings irregularly, the observer may not have recognized the song in the few times it was heard. The magnolia however is common and the reason for its absence from the 5 min spot is not known; Bent (1953) describes the magnolia as a "particularly shy...full-voiced warbler" with a song that is "distinctly different". A spot census method does not appear sensitive enough for delineation of territories of the mourning warbler (Appendix III, Fig. 15), however territories of the magnolia warbler that were delineated were accurate (Appendix III, Fig. 7).

Territorial analysis:

As territories are the basis for analysis, accuracy in the location of each bird and the delineation of each territory is more important than the number of birds censused. (A territory was accurately delineated when it corresponded to the plot method results). If, for a selected species, an observer can census 50% of the population determined with a standard plot census using another method, two censuses could be conducted to give the same number of birds. However, if territories are not accurately placed, a replication of the census may not be sufficient. For example, 53% of the american redstart population (as determined by the plot census) was censused with a transect (Table 6), and territories were correctly delineated (Appendix III, Figure 16). Therefore, doubling the length of the transect would increase the number of territories censused. However, 70% of the blackburnian warblers were censused with a transect, yet what appeared to be two territories were actually three (Appendix III, Fig. 11). To delineate more territories for this species would require a more extensive survey, not a replication of the transect.

Species for which territories could be accurately monitored with spot and transect censuses (winter wren, black-and-white, cape may, yellowrumped, chestnut-sided, nashville and magnolia warblers, ovenbird, and purple finch) (Appendix III, Figs. 2, 4, 3, 9, 12, 6, 7, 14, and 17, respectively) were generally easily recorded or were of low density. Species whose territories were not accurately monitored by spot and transect methods (least flycatcher, tennessee, black-throated green, blackburnian, baybreasted, and mourning warblers, and american redstart) (Appendix III, Figs. 1, 5, 10, 11, 15 and 16) were not easily recorded or of a high density. Territories of the ruby-crowned kinglet (Appendix III, Fig. 3) were accurately delineated with a

Table 6. Percent of the population determined by a standard plot census, that is censused with a 5, 10 and 15 minute spot census and with a transect. Wawa, Ontario 4-16 June 1979

Species	Census Method				
	5 min[a] spot	10 min[a] spot	15 min[a] spot	Transect spot	Plot spot
Least flycatcher	4.3	21.7	24.6	31.9	100 (6.9)[b]
Winter wren	0	100.0	160.0	220.0	100 (1.0)
American robin	25.0	25.0	50.0	50.0	100 (0.4)
Hermit thrush	(0.7)[c]	0	0	0	0
Swainson's thrush	74.0	65.0	77.0	71.0	100 (3.1)
Veery	0	200.0	200.0	800.0	100 (0.1)
Ruby-crowned kinglet	80.0	40.0	80.0	90.0	100 (2.0)
Black-and-white warbler	16.7	50.0	36.7	153.3	100 (0.5)
Tennessee warbler	45.0	35.0	29.0	45.0	100 (5.1)
Nashville warbler	37.0	32.0	53.0	32.0	100 (1.9)
Magnolia warbler	0	33.0	23.0	56.0	100 (7.9)
Cape May warbler	117.0	17.0	100.0	0	100 (0.6)
Yellow-rumped warbler	67.0	67.0	217.0	83.0	100 (0.6)
Black-throated green warbler	56.0	21.0	29.0	35.0	100 (3.4)
Blackburnian warbler	30.0	35.0	30.0	70.0	100 (4.0)
Chestnut-sided warbler	8.0	18.0	30.0	57.0	100 (12.0)
Baybreasted warbler	3.0	8.0	26.0	25.0	100 (10.8)
Ovenbird	82.0	68.0	68.0	93.0	100 (2.8)
Mourning warbler	0	45.0	48.0	90.0	100 (2.9)
Canada warbler	0	11.0	32.0	32.0	100 (1.9)
American redstart	12.0	11.0	7.0	53.0	100 (9.2)
Purple finch	230.0	100.0	100.0	149.0	100 (1.0)
White-throated sparrow	82.0	49.0	82.0	67.0	100 (7.2)
Avg	44.0 ± 54.5	45.7 ± 43.1	65.3 ± 57.8	99.7 ± 160.6	

[a]avg of early and late spot censuses
[b]avg no. of all censuses from 4-16 June inclusive (excluding 10, 13 and 15 June due to adverse weather conditions)
[c]given as avg no. of all censuses because percent could not be computed

5 min spot and transect census. Although only one territory could be delineated with a 10 and 15 min spot, the territories omitted were in fact border territories on the fringe of the census area. Territories of the white-throated sparrow (Appendix III, Fig. 18) were also accurately delineated with a 5 min spot, but not with the other spots or transect, indicating that if this species was chosen as an indicator species, accurate delineation would be possible only with careful censusing.

When results obtained for conspicuous species are compared with those for inconspicuous species, a consistently lower number of inconspicuous species were detected with a spot census (Table 7 and p. 13). This was not the case with the transect method. With a more extensive census method, conspicuousness was not important.

Table 7. Comparison of percent of the population determined by a standard plot census that is censused with a 5, 10 and 15 minute spot and with a transect, for inconspicuous and conspicuous species. Wawa, Ontario, 4-16 June, 1979

Inconspicuous Species	5	10	15	T	P	Conspicuous Species	5	10	15	T	P
Black-and-white warbler	0.5	1.5	1.1	4.6	3.0	Tennessee warbler	2.3	1.8	1.5	2.3	5.1
Cape may warbler	0.7	0.1	0.6	0.0	0.6	Nashville warbler	0.7	0.6	1.0	0.6	1.9
Blackburnian warbler	1.2	1.4	1.2	2.8	4.0	Magnolia warbler	0.0	2.6	1.8	4.4	2.9
Bay-breasted warbler	0.3	0.9	2.8	2.7	10.8	Black-throated green warbler	1.9	0.7	1.0	1.2	3.4
Canada warbler	0.0	0.2	0.6	0.6	1.9	Chestnut-sided warbler	1.0	2.2	3.6	6.8	12
American redstart	1.1	1.0	0.6	4.9	9.2	Ovenbird	2.3	1.9	1.9	2.6	2.8
Total	3.8	5.1	6.9	15.6	29.5		8.2	9.8	10.8	17.9	33.1
% of standard plot	13	17	23	53	100	% of standard plot	25	30	33	54	100

Perhaps, when the observer is able to traverse the area (even with just the center line in the case of the transect), the opportunity for detection is increased. Apparently, a longer time at a stationary point is not sufficient for the censusing of inconspicuous species, as the observer is mainly limited to audio detection and is restricted by the distance at which he can detect the bird.

lying outside the immediate listening area of the observer, could not be detected with the spot or transect methods. With numerous, compact territories the observer had difficulty distinguishing where one territory ended and another began. Therefore, success in the detection of the actual number of territories present (determined by the standard plot census) was lower with a denser population. Conversely, a greater

Ratio of inconspicuous and conspicuous species of warblers

Census method	5 min spot	10 min spot	15 min spot	Transect	Plot
Ratio value	0.5	0.5	0.6	0.9	0.9

A species may be considered inconspicuous if it a) has a song similar to that of other species, b) sings irregularly or is secretive, or c) has a song that is difficult to identify. The cape may, black-and-white, blackburnian and baybreasted warblers all have similar songs, which may cause identification problems. This could explain the missing cape may territories both on the 10 min spot and transect censuses (Appendix III, Fig. 8). The results also indicate some confusion between the cape may and black-and-white warblers (Appendix III, Figs. 8 and 4 - number of days in territory). A more extensive survey, giving more opportunity for sightings, may be necessary.

The proportion of territories delineated with a standard plot census that were also delineated with other methods, was consistently greater for conspicuous species of warblers (Table 8). All census methods required a greater number of censuses in order to delineate territories for inconspicuous species (Table 8). Multiple spot checks would have to be conducted in different locations in order to increase the number of territories censused.

Abundant species were more difficult to census due to the complexity of their territories. For example, with the baybreasted warbler, chestnut-sided warbler, and american redstart, overlapping territories

proportion of the territories were detected where there were fewer to detect--for example in the case of the cape may, nashville, yellow-rumped and blackburnian warblers (Appendix III, Figs. 8, 6, 9 and 11) and the winter wren (Appendix III, Fig. 2).

Although the magnolia warbler, tennessee warbler and least flycatcher were conspicuous and not very abundant, difficulties were also encountered in the delineation of overlapping territories for these species (Appendix III, Figs. 7, 5 and 1), possibly due to the infrequency of counter singing or merely the masking of outlying birds by adjacent ones.

Timing of Spot Censuses:

Species not detected in 'early' or 'late' (time of day) spot censuses (Table 9, Appendix II, Tables 1-6) were mainly species infrequently observed (singing or sighted) within the study area and therefore were of little concern for monitoring purposes. The average number of birds and average number of species (selected species only), censused over the study period, were slightly lower for 'late' spot censuses than 'early' censuses (Table 10). Reductions were mainly of Turdidae but also included Tyrannidae, Troglodytidae, and

Table 8. Number of territories[a] delineated (A), and number of days required to delineate these territories (B) with each census method. Maximum distance each species was audible at with a spot and transect method (C). Wawa, Ontario 4-16 June, 1979

	Inconspicuous Warblers									
	A					B				C
	No. of territories delineated					No. of days required				Distance audible at (meters)
Census method[b]	5	10	15	T	P	5	10	15	T	P	
Black-and-white	0	1	1	3	4	-	2	5	10	8	60
Cape may	1	0	1	0	1	2	-	2	-	4	40
Blackburnian	2	1	2	2	4	4	3	1	5	1	60
Baybreasted	1	1	2	2	10	11	3	3	4	4	60
Redstart	1	1	1	4	10	5	4	7	10	6	60
Avg	1.0	0.8	1.4	2.2	5.8	6	3	4	7	5	60
% of standard plot	17	14	24	38	100						

	Conspicuous Warblers									
	A					B				C
	No. of territories delineated					No. of days required				Distance audible at (meters)
Census method	5	10	15	T	P	5	10	15	T	P	
Tennessee	1	1	1	1	5	2	2	2	2	1	80
Nashville	1	1	1	1	2	2	6	6	6	1	40
Magnolia	0	2	1	3	7	-	2	5	5	3	100
Black-throated green	2	1	1	1	4	1	2	2	3	1	80
Chestnut-sided	1	2	3	5	7	8	7	2	7	8	80
Ovenbird	1	2	2	2	3	2	1	2	1	4	140
Avg	1.0	1.5	1.5	2.2	4.7	3	3	3	4	3	80
% of standard plot	21	32	32	47	100						

[a]only territories occupied for a min. of 2 days
[b]5, 10, and 15 min spots, T = transect, P = plot

Fringillidae (Table 11A). Changes in activity were most prominent for the swainson's thrush, chestnut-sided warbler, and white-throated sparrow (Table 11B). Other notable changes were of the winter wren, ruby-crowned kinglet, nashville warbler, black-burnian warbler, ovenbird and american redstart (Table 11B). There was, however, no difference in the ability to delineate territories for any species (Table 12).

Replications of a 10 min spot on one day:

The experiment was conducted in three different habitat sites (Site 1 - upland deciduous, Site 2 - coniferous, Site 3 - stream bottom deciduous). The population structure of the bird communities is given in Appendix IV, Tables 1-12. For all three sites (Fig. 5), more birds were censused with 5 spots on one day than one spot/day

Table 9. Species not detected in 'early' or 'late' spot censuses which were included in the other. Wawa, Ontario 4-16 June, 1979

	'Early'	'Late'
5 min spot	brown thrasher, american robin	veery
10 min spot	flicker, catbird, brown thrasher, american robin, veery, junco	spruce grouse, least flycatcher, boreal chickadee, cape may warbler, cowbird, pine grosbeak
15 min spot	brown thrasher, junco	

Table 10. Average number of birds and average number of species for 'early' and 'late' spot censuses. Wawa, Ontario, 4-16 June, 1979

	Avg no. of birds		Avg no. of Species	
	'Early census'	'Late census'	'Early census'	'Late census
5 min spot	30.3	26.4	10.7	10.1
10 min spot	30.0	30.5	12.2	12.4
15 min spot	36.8	38.0	14.1	13.5
Total	97.1	94.9	37.0	36.0

over 5 days. This was most apparent for the family Parulidae, but also for Tyrannidae and Turdidae. It is unlikely that the day of 5 consecutive spots was an exceptionally good day for censusing, as the number of birds recorded was generally below the mean number of birds censused for the week (Table 13).

Fewer birds and fewer species were recorded during the first (0400-0500) and last (0900-1000) census periods (Table 14), probably due to daily activity patterns of the birds.

Table 11. Changes in the number of birds censused from 'early' to 'late' spot censuses for A-predominant families and B-selected species. Wawa, Ontario, 4-16 June, 1979

A	5 min spot	10 min spot	15 min spot	Overall change
Tyrannidae	-0.2	-0.6	0.0	-0.8
Troglodytidae	-	-1.2	-0.7	-1.9
Turdidae	-1.9	-0.8	-2.0	-4.7
Sylviidae	+1.2	0.0	+0.2	+1.4
Vireonidae	-0.2	+1.5	+0.2	+1.5
Parulidae	-0.3	+1.0	+1.6	+2.3
Fringillidae	-2.5	+0.4	+0.4	-1.7

B	5 min spot	10 min spot	15 min spot	Overall change
Least flycatcher	-0.2	-0.6	0.0	-0.8
Winter wren	-	-1.2	-0.7	-1.9
Swainson's thrush	-1.4	-1.2	-1.8	-4.4
Ruby-crowned kinglet	+1.2	0.0	+0.2	+1.4
Black-and-white warbler	+0.2	-0.3	+0.7	+0.6
Tennessee warbler	+0.3	-0.2	-0.6	-0.5
Nashville warbler	-0.2	+0.4	+1.2	+1.4
Magnolia warbler	-	-0.4	+0.8	+0.4
Cape may warbler	-0.2	-0.2	-0.4	-0.8
Yellow-rumped warbler	-0.4	+0.4	-0.7	-0.7
Black-throated green warbler	+0.2	-0.2	-0.4	-0.4
Blackburnian warbler	-0.6	-0.4	-0.4	-1.4
Chestnut-sided warbler	+0.4	+1.6	+1.6	+3.6
Baybreasted warbler	-0.2	+0.3	-0.2	-0.1
Ovenbird	+0.2	-1.1	-0.6	-1.5
Mourning warbler	-	-0.7	0.0	-0.7
American redstart	-0.2	+1.2	+0.4	+1.4
Purple finch	-0.6	+0.3	0.0	-0.3
White-throated sparrow	-1.5	-1.1	-0.2	-2.8

Generally, more species were censused with 5 consecutive spot censuses on 1 day than with spot censuses conducted over 5 days (Table 15). Increased diversity was mainly attributed to Tyrannidae, and Parulidae (Table 16). Species that sing later in the day, such as the alder flycatcher and olive-sided flycatcher, are more likely to be counted with a later census, and therefore, the consecutive censuses. Irregular singers may also be more readily counted with consecutive censuses, (for example, the black-and-white and mourning warblers). Species whose song varies more between days (catbird (Mimidae), for example) were, however, recorded more frequently in daily censuses (Table 16). Conspicuous species such as the tennessee, nashville, and chestnut-sided warblers, ovenbird and white-throated sparrow, showed no pattern in detection ability with either method.

Table 12. Comparison of the number of territories and the number of days required to delineate territories using 'early' as opposed to 'late' spot censuses (E = early, L = late). Wawa, Ontario, 4-16 June,1979

Species	No. of territories delineated						No. of days required					
	5 min		10 min		15 min		5 min		10 min		15 min	
	E	L	E	L	E	L	E	L	E	L	E	L
Least flycatcher	0	0	1	1	1	2	-	-	2	2	2	6
Winter wren	0	0	1	0	1	1	-	-	2	-	2	2
Swainson's thrush	2	2	2	2	2	1	8	9	6	9	8	10
Ruby-crowned kinglet	2	2	1	2	1	2	11	4	11	9	5	9
Black-and-white warbler	0	1	1	1	1	1	-	5	2	2	5	4
Tennessee warbler	1	3	1	1	1	1	2	1	2	2	2	2
Nashville warbler	1	1	1	1	1	2	2	5	6	6	6	5
Magnolia warbler	0	0	2	2	1	2	-	-	2	4	5	8
Cape may warbler	1	1	0	0	1	1	2	2	-	-	2	3
Yellow-rumped warbler	1	0	0	1	1	1	8	-	-	6	5	3
Black-throated green warbler	2	2	1	1	1	1	1	1	2	7	2	2
Blackburnian warbler	2	1	1	1	2	1	4	3	3	3	1	2
Chestnut-sided warbler	1	1	2	3	3	3	8	6	7	9	2	1
Baybreasted warbler	1	0	1	1	2	2	11	-	3	3	3	2
Ovenbird	1	2	2	1	2	2	2	1	1	3	2	1
Mourning warbler	0	0	1	1	1	1	-	-	2	3	5	4
American redstart	1	2	1	1	1	1	5	9	4	6	7	2
Purple finch	2	1	1	1	2	1	6	2	8	4	11	3
White-throated sparrow	6	4	3	4	4	5	8	8	9	8	7	10
	1.3	1.3	1.3	1.4	1.6	1.7	5.6	4.3	4.2	5.4	4.6	4.4

A similar number of territories were delineated with both spot methods (Table 17), and there was no apparent change in the positioning of these territories.

DISCUSSION AND CONCLUSIONS

Many authors, in comparing a plot census to transect (line-transect, strip/line transect etc.) or spot censuses, compare the territory mapping method to a 'count' where only the numbers of individuals are recorded, not their position (Franzreb 1976, Erskine 1977, and Emlen 1977). The mapping method is recognized by many authors as the superior method, allowing for more precision and the measurement of subtle changes (Germain 1980, Erskine 1977). In this experiment however, the mapping method was used for all census techniques, varying only the census area. Germain and Morin (1979) used the mapping method to compare census results for a 'standard quadrat' or plot to a long, narrow plot, and found that variations in numbers were much more affected by differences in habitat than plot shape.

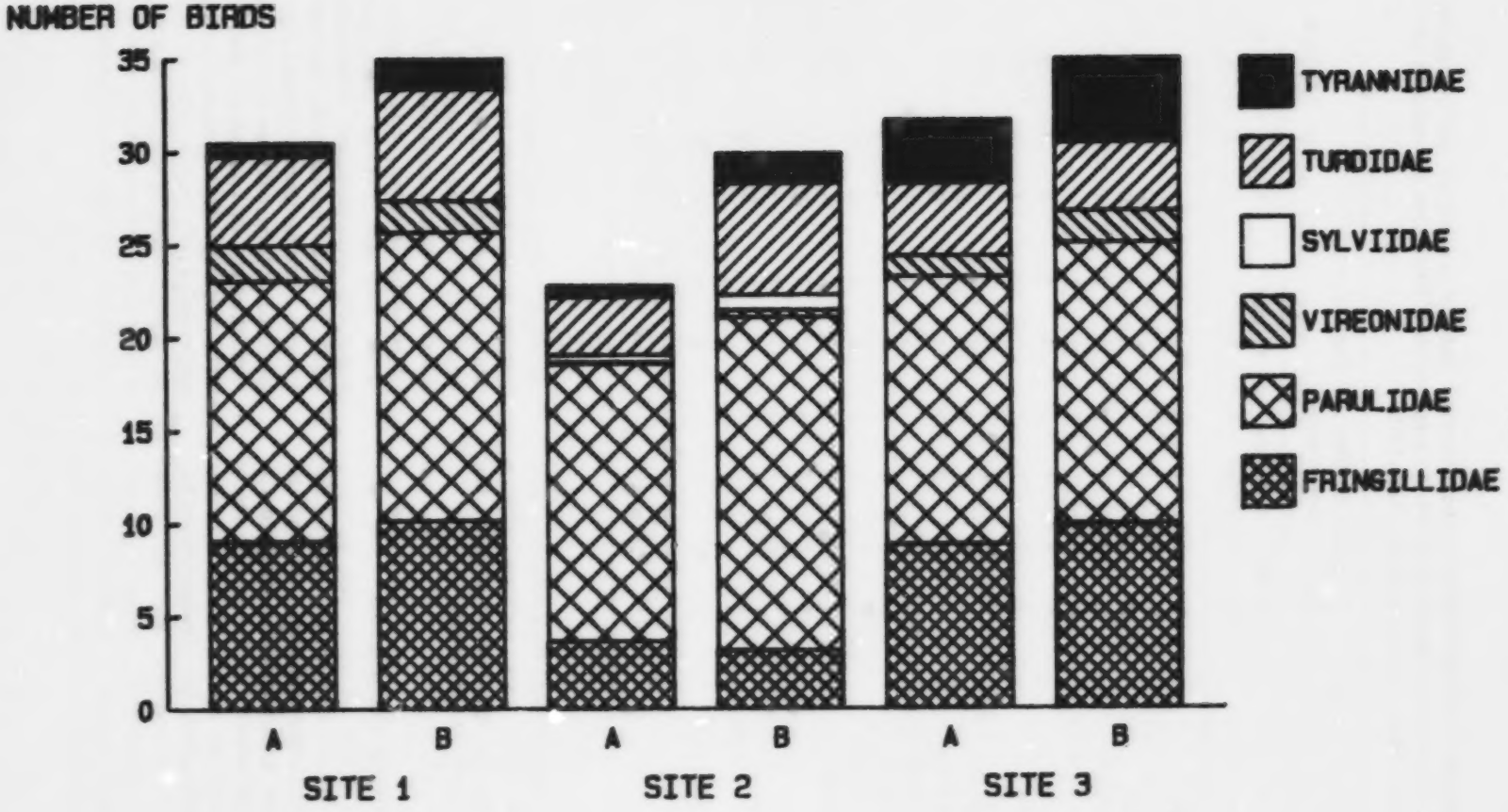

Figure 5. Comparison of the number of birds censused with 5 spots on 1 day (B) versus 1 spot per day over 5 days (A).

Table 13. Comparison of activity on the day of 5 consecutive spots to activity during that week

	26-30 May	9-12 June	23-27 June	7-11 July	Total
Site 1	-1.0[a]	+6.5	-5.0	-3.0	-2.5
Site 2	+5.0	+6.7	-8.6	-8.2	-5.1
Site 3	-9.2	+24.7	-5.8	-0.8	+8.9
Total	-5.2	+37.9	-19.4	-12.0	

[a]no. of birds on the day of 5 censuses minus the mean no. of birds for that week

Table 14. Number of birds and number of species recorded during each of the 5 spot censuses

	Spot Censuses						
	Time of Census[a]						
	0400-0500	0500-0600	0600-0700	0700-0800	0800-0900	0900-1000	Avg
Site 1							
29 May		42/13	34/11	52/14	25/ 9	19/ 7	34.4/10.8
12 June	38/ 7	32/ 8	28/11	30/10	40/ 9		33.6/ 9.0
26 June		46/ 9	32/10	42/10	36/ 7	40/10	39.2/ 9.2
10 July	32/ 8	28/ 8	36/ 9	34/10	38/ 9		33.6/ 8.8
Site 2							
29 May		48/17	28/ 9	44/15	24/ 9	22/ 8	33.2/11.6
12 June	37/13	34/12	36/13	30/11	28/11		33.0/12.0
26 June		20/ 7	24/11	36/12	34/13	32/11	29.2/10.8
10 July	26/ 8	20/ 6	28/ 7	32/ 6	20/ 7		25.2/ 6.8
Site 3							
29 May		31/11	52/14	37/11	44/14	36/ 9	40.0/11.8
12 June	20/ 6	54/16	42/16	48/15	27/11		38.2/12.8
26 June		34/13	28/11	37/13	40/14	36/10	35.0/12.2
10 July	20/ 9	23/ 9	22/ 7	29/ 9	24/ 9		23.6/ 8.6
Avg	28.8/8.5	34.3/10.8	32.5/10.8	37.6/11.3	31.7/10.2	30.8/ 9.2	

[a]censuses conducted between these hours
A/B Where A = total no. of birds and B = total no. of species (selected species only)

Table 15. Species diversity on three different sites over the breeding season. S1 = 5 spots/day, S5 = 1 spot/day for 5 days

Census Method	Site 1		Site 2		Site 3	
	S1	S5	S1	S5	S1	S5
Date						
26-30 May	10.8	9.8	11.6	8.6	11.8	10.8
9-12 June	9.0	7.5	12.0	10.5	12.8	10.5
23-27 June	9.2	8.6	10.8	10.4	12.2	13.8
7-11 July	8.8	7.6	6.8	7.8	8.6	9.8
Avg	9.5	8.4	10.3	9.3	11.4	11.2

Table 16. Comparison of species diversity of the major families with two different spot methods for all sites combined and averaged over the entire breeding season. S1 = 5 spots/day, S5 = 1 spot/day for 5 days

Census Method Family	S1	S5
Tyrannidae	1.1	0.7
Mimidae	0.1	0.2
Turdidae	1.9	1.8
Vireonidae	0.7	0.5
Parulidae	4.3	3.9
Fringillidae	1.9	2.1

Table 17. Comparison of number of territories delineated for selected species using three different census methods. S1 = 5 spots/day, S5 = 1 spot/day for 5 days

Census Method	S1	S5
Species		
Hermit thrush	2.3	1.5
Nashville warbler	4.3	4.5
Blackburnian warbler	1.8	1.8
Chestnut-sided warbler-Site 1	2.8	2.3
Chestnut-sided warbler-Site 2	0.8	0.5
Chestnut-sided warbler-Site 3	2.8	3.5
Baybreasted warbler	1.5	1.0
Ovenbird	4.0	3.3
Rose-breasted grosbeak	3.5	3.3
White-throated sparrow	3.5	3.0

All data analysis in this experiment was conducted by one person, eliminating the problem of discrepancy in data interpretation which Emlen (1977), Svensson (1974), and Best (1975) have identified. To minimize observer bias, all observers were trained for consistency in both identification and location of the bird.

The results indicate that relative abundance and species diversity generally increased with a greater amount of time on the plot. Dickson (1978) attributes this to an increased probability of encountering birds. However, we found that more easily identifiable species were better censused with a 5 min spot than some of the other methods. This was presumably because the observer concentrated on these species entirely, unconsciously ignoring more difficult, inconspicuous species. Van Riper III (1981) reported that common birds entirely mask the presence of silent or rare species. If conspicuous species were chosen as indicators, the observer could quite accurately census these species with a 5 min spot; with inconspicuous species a more extensive census method is required.

Overall, there was little difference in the number of birds censused with a 5 as opposed to a 10 min spot (Table 6), although some species were missed with the 5 min spot. Dawson and Bull (1975) found 5 min to be no less accurate than 10, in fact, there was less opportunity to record the same individual twice and it allowed the observer to sample more forest. Germain (1980) in his review of methodology, suggested a spot census should not be less than 3 min or more than 10. Erskine (1977) reported that 60% of the total number of birds detected in 15 min were detected in the first 3 min. We found an average of 81% of the total number of birds detected in 15 min were detected in 5 min. DeSante (1981) found spot censuses to underestimate densities anywhere from 2-70%, depending on the species. In this study, accuracy was dependent on the conspicuousness of the species, and density of the population; conspicuous species of low density were more than adequately censused with a 5 min spot.

As monitoring does not require a complete cataloguing of the bird population, selecting indicator species which can be adequately censused with spot methods may be a more efficient means of providing data. The 5 min spot was most efficient. Accordingly, Germain and Morin (1979) recommend a combination of territory-mapping and roadside point-count surveys looking at only 'indicator species'. Limitations of this increased efficiency are: loss in precision (Emlen 1977), and uncertainty about individual birds, their behaviour and territories (Germain 1980).

The transect census allows increased contact, and if designed properly, can include all major habitat areas within the treated area with minimal driving time and maximum censusing time. It also allows for the leisurely checking of unknowns on the return trek. Although Drury et al. (1980) report a high probability that an individual bird will be missed using a transect, we found that the number of birds censused with the transect method closely approached that of the plot census method (Table 6). Nonetheless, without an exact plot boundary, subtle decreases in singing may be masked due to the tendency to record a greater proportion of singing birds when fewer birds are present (Pearce et al. 1979; Germain and Tingley 1980).

The plot method is the most sensitive and most accurate, as plot boundaries are strictly defined and the opportunity for close observations of individuals exists. (This is confirmed with the observed increase in ability to delineate territories). However, this method requires a considerable initial effort in the preparation of plots, and restricts the census area to a small perhaps unrepresentative portion of the treatment block. With increased time on the plot, the possibility of recording an individual more than once is also increased (Dickson 1978). However, with territorial mapping this problem can be alleviated.

If under a time constraint or if weather will not permit the replication of a sufficient number of daily censuses, replicates within one day should be considered, permitting the same amount of census time within a shorter time interval. The results indicate that species diversity and the number of birds censused, were greater with multiple replications on one day than with the same number of censuses conducted daily. The number of territories delineated was good and placement of these territories very accurate. However, if time and weather conditions permit, it would be preferable to cover a greater area of the block rather than repeating censuses in the same area, in case of double-swathing, a complete miss etc.

In summary, each census method examined has its merits. However, the method most suitable will depend upon the circumstances. The spot census method is useful in a situation where coverage of a large area is necessary with minimal personnel. A transect allows for increased contact, and if designed properly can include all major habitat areas within the treatment block with minimal driving time, and maximum censusing time. The plot method is most sensitive, allowing for the most accurate placement of territories, and the most contact with individual birds. I would, therefore, recommend: 1) under the current move towards smaller treatment blocks (in the range of 100 ha), the plot method for more detailed observations of individual birds and their movement; 2) If a greater area is treated (1000 ha), the transect method, using territorial mapping, would be preferable; 3) To cover a larger area with less personnel, the spot method would be recommended provided censuses were concentrated on indicator species that are conspicuous and not at a high density. Spot census stations could be located near territories of these indicator species.

For a more thorough overview of songbird methodology for impact assessment, the reader is referred to Germain's paper (1980).

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APPENDIX I

Common and scientific names of bird species censused

Common and scientific names of bird species censused

and their short forms as used in the text

Scientific name	Common name	Symbol
Canachites canadensis	Spruce Grouse	SPG
Bonasa umbellus	Ruffed Grouse	RUF
Colaptes auratus	Common Flicker	F
Sphyrapicus varius	Yellow-bellied Sapsucker	YBS
Sayornis phoebe	Eastern Pheobe	EPH
Empidonax flaviventris	Yellow-bellied Flycatcher	YBF
Empidonax traillii	Alder Flycatcher	AFC
Empidonax minimus	Least Flycatcher	LFC
Perisoreus canadensis	Gray Jay	GJ
Cyanocitta cristata	Blue Jay	BJ
Parus atricapillus	Black-capped Chickadee	BCC
Parus hudsonicus	Boreal Chickadee	BOC
Certhia familiaris	Brown Creeper	BRC
Troglodytes troglodytes	Winter Wren	W
Dumetella carolinensis	Catbird	CAT
Toxostoma rufum	Brown Thrasher	BT
Turdus migratorius	American Robin	R
Hylocichla guttata	Hermit Thrush	HT
Hylocichla ustulata	Swainson's Thrush	ST
Hylocichla fuscescens	Veery	V
Regulus calendula	Ruby-crowned Kinglet	RCK

Scientific name	Common name	Symbol
Vireo solitarius	Solitary Vireo	SV
Vireo olivaceus	Red-eyed Vireo	RV
Vireo phildelphicus	Philadelphia Vireo	PHV
Mniotilta varia	Black-and-white Warbler	BW
Vermivora peregrina	Tennessee Warbler	TE
Vermivora ruficapilla	Nashville Warbler	NA
Dendroica magnolia	Magnolia Warbler	MA
Dendroica tigrina	Cape May Warbler	CM
Dendroica coronata	Yellow-rumped Warbler	YR
Dendroica virens	Black-throated Green Warbler	BGN
Dendroica fusca	Blackburnian Warbler	BBN
Dendroica pensylvanica	Chestnut-sided Warbler	CSW
Dendroica castanea	Bay-breasted Warbler	BA
Seiurus aurocapillus	Ovenbird	OV
Oporornis philadelphia	Mourning Warbler	MO
Wilsonia canadensis	Canada Warbler	CA
Setophaga ruticilla	American Redstart	RST
Molothrus ater	Brown-headed Cowbird	COW
Pheucticus ludovicianus	Rose-breasted Grosbeak	RBG
Carpodacus purpureus	Purple Finch	PF
Pinicola enucleator	Pine Grosbeak	PIG
Junco hyemalis	Slate-colored Junco	J
Spizella passerina	Chipping Sparrow	CHP
Zonotrichia albicollis	White-throated Sparrow	WTS

APPENDIX II

Population studies of bird communities on a 4 ha plot censused with varying methodologies. Wawa, Ontario, 1979.

Table 1
Forest Bird Population Census
Methodology - 5 minute point census (early)
4 June - 16 June, 1979
Wawa, Ontario

Family	Species	June 4	June 5	June 6	June 7	June 8	June 9	June 11	June 12	June 14	June 15	July 16	Daily Avg
Tyrannidae	Least flycatcher	0	0	0	0	0	0	0	0	0	0	4	0.4
Corvidae	Blue jay	0	0	0	0	0	2	0	0	0	0	1	0.3
Paridae	Boreal chickadee	0	0	0	2	0	0	0	0	0	0	0	0.2
Sittidae	Red-breasted nuthatch	0	2	0	2	0	0	0	2	0	0	2	0.7
Turdidae	Hermit thrush	1	1	1	0	1	0	2	3	0	0	1	0.9
	Swainson's thrush	1	2	2	2	3	4	2	4	5	4	5	3.1
	Veery	0	0	0	0	0	0	0	0	0	2	0	0.2
Sylviidae	Ruby-crowned kinglet	0	2	0	0	0	0	0	2	2	0	4	0.9
Vireonidae	Solitary vireo	4	2	2	2	0	2	4	4	4	0	2	2.4
Parulidae	Black-and-white warbler	0	0	0	0	0	2	0	2	0	0	0	0.4
	Tennessee warbler	4	4	2	2	2	1	0	2	2	2	2	2.1
	Nashville warbler	2	2	0	0	0	2	2	0	0	0	0	0.7
	Cape may warbler	2	2	2	0	2	0	0	0	0	0	0	0.7
	Yellow-rumped warbler	2	0	0	0	0	0	2	0	0	0	2	0.5
	Black-throated green warbler	4	2	4	2	0	2	0	0	2	0	2	1.6
	Blackburnian warbler	0	2	0	4	4	4	0	0	0	2	0	1.5
	Chestnut-sided warbler	0	0	0	0	0	0	2	2	2	0	2	0.7
	Bay-breasted warbler	0	0	0	0	2	0	0	0	0	0	2	0.4
	Ovenbird	2	2	2	2	2	2	4	2	2	2	2	2.2
	American redstart	0	2	0	0	2	0	2	2	2	2	2	1.3
Fringillidae	Purple finch	2	2	2	2	2	4	4	2	2	2	4	2.5
	Dark-eyed junco	2	0	0	0	0	0	0	2	0	0	2	0.5
	White-throated sparrow	4	6	6	2	6	6	8	10	8	8	10	6.7
Total Birds		30	33	23	22	26	31	32	39	31	24	49	30.9
Total Species		12	14	9	10	10	11	10	13	10	8	17	11.3

Table 2
Forest Bird Population Census
Methodology - 5 minute point census (late)
4 June - 16 June, 1979
Wawa, Ontario

Family	Species	June 4	June 5	June 6	June 7	June 8	June 9	June 11	June 12	June 14	July 16	Daily Avg
Tyrannidae	Least flycatcher	0	0	0	0	0	0	0	0	0	2	0.2
Corvidae	Blue jay	0	0	0	0	0	2	0	1	0	0	0.3
Paridae	Boreal chickadee	0	0	0	2	0	0	0	0	0	0	0.2
Sittidae	Red-breasted nuthatch	2	0	2	0	0	0	0	0	0	2	0.6
Mimidae	Brown thrasher	0	0	0	0	0	2	0	0	0	0	0.2
Turdidae	American robin	0	0	0	0	0	0	2	0	0	0	0.2
	Hermit thrush	1	0	0	1	1	0	0	0	0	0	0.3
	Swainson's thrush	0	1	1	0	1	1	3	3	4	2	1.6
Sylviidae	Ruby-crowned kinglet	2	4	0	4	4	0	2	2	4	0	2.2
Vireonidae	Solitary vireo	2	2	0	2	2	4	2	4	2	4	2.4
Parulidae	Black-and-white warbler	2	0	0	0	2	0	0	0	0	2	0.6
	Tennessee warbler	6	2	2	2	2	2	0	4	2	2	2.4
	Nashville warbler	0	2	0	0	2	2	0	0	0	0	0.6
	Cape May warbler	2	2	0	2	0	0	0	0	0	0	0.6
	Yellow-rumped wabler	0	0	0	0	0	0	0	0	0	2	0.2
	Black-throated green warbler	4	2	2	0	2	2	4	0	4	0	2.0
	Blackburnian warbler	0	2	2	2	0	2	2	0	0	0	1.0
	Chestnut-sided warbler	0	0	2	0	0	2	2	2	2	2	1.2
	Bay-breasted warbler	0	0	0	0	0	2	0	0	0	0	0.2
	Ovenbird	4	2	2	2	4	2	2	2	0	4	2.4
	American redstart	0	0	0	0	0	2	2	2	4	0	1.0
Fringillidae	Purple finch	2	2	2	2	2	2	2	2	2	2	2.0
	Dark-eyed junco	0	0	0	0	0	0	0	0	0	2	0.2
	White-throated sparrow	6	6	6	3	5	4	7	5	3	6	5.1
Total Birds		33	27	21	22	27	31	30	27	27	32	27.7
Total Species		11	11	9	10	11	14	11	10	9	12	10.8

Table 3
Forest Bird Population Census
Methodology - 10 minute point census (early)
4 June - 16 June, 1979
Wawa, Ontario

Family	Species	June 4	June 5	June 6	June 7	June 8	June 9	June 11	June 12	June 14	June 15	July 16	Daily Avg
Tetraonidae	Spruce grouse	1	0	0	0	0	0	0	0	0	0	0	0.1
Picidae	Yellow-bellied sapsucker	0	0	0	0	0	1	1	0	0	0	1	0.2
Tyrannidae	Least flycatcher	2	2	2	2	2	2	2	2	0	0	2	1.6
Paridae	Boreal chickadee	0	0	0	1	0	0	0	0	0	0	0	0.1
Sittidae	Red-breasted nuthatch	2	2	0	2	0	0	0	2	0	0	0	0.7
Troglodytidae	Winter wren	2	2	2	2	2	2	0	2	0	0	2	1.5
Turdidae	Swainson's thrush	1	2	2	2	5	4	3	2	2	8	3	3.1
Sylviidae	Ruby-crowned kinglet	0	0	2	0	0	0	0	2	2	0	2	0.7
Vireonidae	Solitary vireo	0	0	2	0	0	0	0	0	0	0	0	0.2
	Red-eyed vireo	2	0	0	0	0	0	0	0	0	0	0	0.2
	Philadelphia vireo	0	0	0	0	4	2	2	4	2	0	2	1.5
Parulidae	Black-and-white warbler	2	2	2	2	2	0	2	2	0	0	2	1.5
	Tennessee warbler	2	2	2	2	2	4	0	0	2	2	2	1.8
	Nashville warbler	0	0	0	0	2	2	0	0	0	0	0	0.4
	Magnolia warbler	0	4	2	4	6	2	4	2	2	0	2	2.5
	Cape May warbler	0	0	0	0	0	0	0	0	0	0	2	0.2
	Yellow-rumped warbler	0	0	0	2	0	0	0	0	0	0	0	0.2
	Black-throated green warbler	2	2	2	0	0	0	2	0	0	0	0	0.7
	Blackburnian warbler	0	4	4	2	0	2	0	2	2	2	0	1.6
	Chestnut-sided warbler	2	0	0	0	2	4	4	2	0	2	0	1.5
	Bay-breasted warbler	0	2	2	2	0	2	0	0	0	0	0	0.7
	Ovenbird	4	2	2	4	2	2	2	2	2	2	2	2.4
	Mourning warbler	2	2	2	2	2	2	0	0	2	0	4	1.5
	Canada warbler	0	0	0	0	0	0	0	0	0	2	0	0.2
	American redstart	0	2	0	2	0	0	0	0	0	0	0	0.4

Table 3 cont'd
Forest Bird Population Census
Methodology - 10 minute point census (early)
4 June - 16 June, 1979
Wawa, Ontario

Family	Species	June 4	June 5	June 6	June 7	June 8	June 9	June 11	June 12	June 14	June 15	July 16	Daily Avg
Icteridae	Brown-headed cowbird	0	0	0	0	0	0	0	2	0	0	0	0.2
Fringillidae	Purple finch	0	0	2	0	0	0	0	2	0	0	4	0.7
	Pine grosbeak	0	0	0	0	0	2	0	0	0	0	0	0.2
	Chipping sparrow	0	0	0	0	0	0	0	0	0	0	2	0.2
	White-throated sparrow	2	4	4	4	2	4	4	6	6	4	2	3.8
Total Birds		26	34	34	35	33	37	26	34	22	22	34	30.6
Total Species		13	14	15	15	12	15	10	14	9	7	15	12.5

Table 4
Forest Bird Population Census
Methodology - 10 minute point census (late)
4 June - 16 June, 1979
Wawa, Ontario

Family	Species	June 4	June 5	June 6	June 7	June 8	June 9	June 11	June 12	June 14	July 16	Daily Avg
Picidae	Common flicker	0	0	0	2	0	0	1	0	0	0	0.3
	Yellow-bellied sapsucker	0	0	0	0	0	1	1	0	0	1	0.3
Tyrannidae	Least flycatcher	2	2	2	2	2	2	0	0	0	0	1.2
Sittidae	Red-breasted nuthatch	2	0	2	0	0	0	0	0	0	2	0.6
Troglodytidae	Winter wren	2	0	0	2	0	0	0	0	0	0	0.4
Mimidae	Catbird	0	1	0	0	0	0	0	0	0	0	0.1
	Brown thrasher	0	0	0	0	0	2	0	0	0	0	0.2
Turdidae	American robin	0	0	0	0	1	0	0	0	0	0	0.1
	Swainson's thrush	1	1	0	1	1	0	1	2	4	3	1.4
	Veery	0	0	1	0	2	0	0	0	0	0	0.3
Sylviidae	Ruby-crowned kinglet	0	2	0	0	0	0	0	2	4	0	0.8
Vireonidae	Solitary vireo	4	4	0	0	0	0	0	0	0	0	0.8
	Red-eyed vireo	0	0	4	0	0	0	0	0	0	0	0.4
	Philadelphia vireo	0	0	2	4	4	4	2	2	2	4	2.4
Parulidae	Black-and-white warbler	2	2	2	0	2	2	2	1	0	0	1.3
	Tennessee warbler	2	2	2	2	2	2	0	2	2	2	1.8
	Nashville warbler	0	0	0	0	2	2	0	2	2	0	0.8
	Magnolia warbler	2	2	2	4	6	2	4	0	0	2	2.4
	Yellow-rumped warbler	0	2	0	0	2	2	0	0	0	0	0.6
	Black-throated green warbler	4	0	0	0	0	0	2	0	0	0	0.6
	Blackburnian warbler	2	0	4	0	2	2	0	2	0	0	1.2
	Chestnut-sided warbler	4	5	2	0	4	4	2	6	4	2	3.0
	Bay-breasted warbler	0	2	2	2	2	2	0	0	0	2	1.1

Table 4 cont'd
Forest Bird Population Census
Methodology - 10 minute point census (late)
4 June - 16 June, 1979
Wawa, Ontario

Family	Species	June 4	June 5	June 6	June 7	June 8	June 9	June 11	June 12	June 14	July 16	Daily Avg
Parulidae (cont'd)	Ovenbird	2	2	2	2	0	0	2	4	0	0	1.3
	Mourning warbler	2	0	2	2	0	2	0	0	0	4	1.1
	Canada warbler	4	0	0	0	0	0	0	0	0	0	0.4
	American redstart	2	0	1	1	0	2	0	0	3	2	1.6
Fringillidae	Purple finch	0	0	2	2	0	2	2	2	2	0	1.1
	Dark-eyed junco	2	0	0	0	0	0	0	0	0	0	0.2
	Chipping sparrow	0	0	0	0	0	2	2	0	0	2	0.5
	White-throated sparrow	2	4	2	6	2	4	4	6	2	2	3.1
Total Birds		41	31	34	32	34	39	25	31	25	28	32.0
Total Species		17	13	16	13	14	17	12	11	9	12	13.4

Table 5
Forest Bird Population Census
Methodology - 15 minute point census (early)
4 June - 16 June, 1979
Wawa, Ontario

Family	Species	June 4	June 5	June 6	June 7	June 8	June 9	June 11	June 12	June 14	June 15	July 16	Daily Avg
Picidae	Common flicker	0	0	0	1	0	2	1	0	0	0	0	0.4
	Yellow-bellied sapsucker	0	0	0	0	0	0	1	1	0	0	2	0.4
Tyrannidae	Least flycatcher	2	2	2	2	2	2	2	2	0	0	2	1.6
Paradiae	Black-capped chickadee	0	4	0	1	0	0	0	0	0	0	0	0.5
	Boreal chickadee	0	0	0	1	0	0	0	0	0	0	0	0.1
Sittidae	Red-breasted nuthatch	2	2	2	4	0	0	0	2	0	0	0	1.1
Troglodytidae	Winter wren	2	2	2	2	2	2	1	2	2	2	2	1.9
Turdidae	American robin	0	0	0	0	0	0	0	1	0	0	2	0.3
	Swainson's thrush	1	2	1	2	4	3	4	5	4	3	7	3.3
	Veery	0	2	0	0	0	0	0	0	0	0	0	0.2
Sylviidae	Ruby-crowned kinglet	0	0	0	2	2	0	0	2	2	0	2	0.9
Vireonidae	Red-eyed vireo	2	0	2	2	2	2	2	4	2	0	2	1.8
	Philadelphia vireo	0	0	0	0	2	2	0	0	2	2	0	0.7
Parulidae	Black-and-white warbler	0	0	0	2	2	2	0	2	0	0	0	0.7
	Tennessee warbler	2	2	2	2	2	2	0	0	4	2	2	1.8
	Nashville warbler	0	0	0	0	2	2	0	0	0	0	0	0.4
	Magnolia warbler	0	2	0	2	6	0	2	0	2	0	0	1.3
	Cape May warbler	4	2	2	0	0	0	0	0	0	0	0	0.7
	Yellow-rumped warbler	0	0	2	0	2	2	0	2	4	0	4	1.5
	Black-throated green warbler	2	2	2	2	0	0	2	2	0	0	0	1.1
	Blackburnian warbler	4	4	2	0	0	2	0	0	0	0	2	1.3
	Chestnut-sided warbler	4	6	2	0	2	4	4	2	2	2	2	2.7
	Bay-breasted warbler	2	6	4	2	4	4	0	2	0	0	5	2.6
	Ovenbird	2	4	2	2	2	2	2	4	2	2	0	2.2
	Mourning warbler	2	2	0	2	2	2	0	0	2	0	2	1.3
	Canada warbler	2	0	0	0	0	0	0	2	0	2	0	0.5
	American redstart	0	0	0	0	0	2	2	0	0	0	0	0.4

Table 5 cont'd
Forest Bird Population Census
Methodology - 15 minute point census (early)
4 June - 16 June, 1979
Wawa, Ontario

Family	Species	June 4	June 5	June 6	June 7	June 8	June 9	June 11	June 12	June 14	June 15	July 16	Daily Avg
Fringillidae	Purple finch	0	0	2	0	0	2	0	2	0	2	4	1.1
	Pine grosbeak	0	0	0	0	0	0	2	0	0	0	0	0.2
	Chipping sparrow	0	0	0	0	0	0	0	0	0	0	4	0.4
	White-throated sparrow	4	8	8	4	8	6	6	6	4	6	6	6.0
Total Birds		37	52	37	35	46	45	31	43	32	23	50	39.3
Total Species		15	16	15	17	16	18	13	17	12	9	16	14.9

Table 6
Forest Bird Population Census
Methodology - 15 minute point census (late)
4 June - 16 June, 1979
Wawa, Ontario

Family	Species	June 4	June 5	June 6	June 7	June 8	June 9	June 11	June 12	June 14	July 16	Daily Avg
Picidae	Common flicker	0	0	0	2	0	1	1	0	0	0	0.4
	Yellow-bellied sapsucker	0	1	0	0	0	0	0	0	0	0	0.1
Tyrannidae	Least flycatcher	2	2	2	4	2	2	2	2	0	0	1.6
Paridae	Black-capped chickadee	0	0	2	2	0	0	0	0	0	0	0.4
	Boreal chickadee	0	0	0	1	0	0	0	0	0	0	0.1
Sittidae	Red-breasted nuthatch	2	0	2	0	2	0	0	2	0	2	1.0
Troglodytidae	Winter wren	2	4	0	2	0	2	0	0	2	0	1.2
Mimidae	Brown thrasher	0	0	0	0	0	2	0	0	0	0	0.2
Turdidae	American robin	0	0	0	0	1	0	0	0	0	0	0.1
	Swainson's thrush	1	1	0	1	2	1	2	2	2	3	1.5
	Veery	0	0	0	0	2	0	0	0	0	0	0.2
Sylviidae	Ruby-crowned kinglet	2	2	0	0	0	2	0	4	2	0	1.2
Vireonidae	Red-eyed vireo	2	4	2	4	0	4	0	2	2	2	2.2
	Philadelphia vireo	0	0	2	0	2	0	0	0	0	2	0.6
Parulidae	Black-and-white warbler	0	0	4	4	3	2	2	0	0	0	1.5
	Tennessee warbler	2	2	2	2	2	2	0	0	0	0	1.2
	Nashville warbler	0	0	0	0	4	2	2	4	2	2	1.6
	Magnolia warbler	0	2	2	0	4	2	4	4	2	2	2.2
	Cape May warbler	0	2	2	0	0	0	0	0	0	0	0.4
	Yellow-rumped warbler	0	2	2	3	0	0	0	2	0	0	0.9
	Black-throated green warbler	2	2	2	0	0	0	2	0	0	0	0.8
	Blackburnian warbler	2	2	2	0	2	0	0	0	0	2	1.0
	Chestnut-sided warbler	6	2	4	4	4	6	2	4	6	6	4.4
	Bay-breasted warbler	4	4	2	2	0	5	4	2	0	4	2.7

Table 6 (cont'd)
Forest Bird Population Census
Methodology - 15 minute point census (late)
4 June - 16 June, 1979
Wawa, Ontario

Family	Species	June 4	June 5	June 6	June 7	June 8	June 9	June 11	June 12	June 14	July 16	Daily Avg
Parulidae	Ovenbird	4	2	2	2	0	0	4	2	0	0	1.6
(cont'd)	Mourning warbler	2	2	2	2	0	2	0	0	0	4	1.4
	Canada warbler	1	2	0	0	0	0	4	0	0	0	0.7
	American redstart	0	2	3	0	0	0	0	0	3	0	0.8
Fringillidae	Purple finch	0	2	2	0	0	2	0	4	0	0	1.0
	Pine grosbeak	0	0	0	0	0	0	2	0	0	0	0.2
	Dark-eyed junco	2	0	0	0	0	0	0	0	0	0	0.2
	Chipping sparrow	0	0	0	0	0	2	0	0	2	4	0.8
	White-throated sparrow	4	4	6	8	6	10	6	6	2	6	5.8
Total Birds		40	46	47	43	36	49	37	40	25	39	40.0
Total Species		16	20	19	15	13	17	13	13	10	12	14.8

Table 7
Forest Bird Population Census
Methodology Transect
4 June - 16 June, 1979
Wawa, Ontario

Family	Species	June 4	June 5	June 6	June 7	June 8	June 9	June 11	June 12	June 14	July 16	Daily Avg
Tetraonidae	Ruffed grouse	0	2	0	0	0	0	0	0	0	0	0.2
Picidae	Common flicker	1	1	0	2	0	0	0	0	0	0	0.4
	Yellow-bellied sapsucker	0	0	0	0	0	0	2	1	0	0	0.3
Tyrannidae	Eastern phoebe	0	0	2	0	0	0	0	0	0	0	0.2
	Least flycatcher	2	2	2	4	2	2	4	2	0	2	2.2
Corvidae	Blue jay	0	1	0	0	0	0	0	0	0	0	0.1
Paridae	Black-capped chickadee	0	1	0	0	0	1	0	0	0	0	0.2
	Boreal chickadee	0	0	0	2	0	0	0	0	0	0	0.2
Sittidae	Red-breasted nuthatch	0	2	0	0	2	0	0	2	0	0	0.6
Certhiidae	Brown creeper	0	0	0	1	2	0	0	0	0	0	0.3
Troglodytidae	Winter wren	2	2	2	2	2	4	2	2	2	2	2.2
Mimidae	Catbird	0	0	1	0	0	0	0	0	0	0	0.1
Turdidae	American robin	0	0	0	0	0	2	0	0	0	0	0.2
	Swainson's thrush	1	2	2	2	1	0	2	1	3	8	2.2
	Veery	1	3	0	1	1	0	2	0	0	0	0.8
Sylviidae	Ruby-crowned kinglet	4	2	0	2	4	2	2	0	0	2	1.8
Vireonidae	Solitary vireo	0	2	0	4	0	0	0	0	0	0	0.6
	Red-eyed vireo	2	0	0	2	0	0	0	0	0	0	0.4
	Philadelphia vireo	0	0	6	0	4	2	10	4	6	8	4.0

Table 7 cont'd
Forest Bird Population Census
Methodology Transect
4 June - 16 June, 1979
Wawa, Ontario

Family	Species	June 4	June 5	June 6	June 7	June 8	June 9	June 11	June 12	June 14	June 16	Daily Avg
Parulidae	Black-and-white warbler	6	4	6	4	4	4	6	6	2	4	4.6
	Tennessee warbler	2	2	2	2	2	0	3	2	4	4	2.3
	Nashville warbler	0	0	0	0	2	2	0	0	2	0	0.6
	Magnolia warbler	2	8	4	6	8	6	2	4	2	2	4.4
	Yellow-rumped warbler	0	0	0	0	2	0	0	0	3	0	0.5
	Black-throated green warbler	2	0	2	2	2	0	2	2	0	0	1.2
	Blackburnian warbler	4	0	2	0	6	2	4	4	0	6	2.8
	Chestnut-sided warbler	8	4	6	6	6	7	12	8	3	8	6.8
	Bay-breasted warbler	0	2	6	4	6	1	2	2	2	2	2.7
	Ovenbird	4	2	0	4	2	2	4	4	2	2	2.6
	Mourning warbler	2	0	2	2	2	6	4	2	2	4	2.6
	Canada warbler	2	2	0	0	0	0	0	0	0	2	0.6
	American redstart	4	4	5	4	4	6	4	4	6	8	4.9
Fringillidae	Purple finch	0	4	2	0	0	0	2	2	2	2	1.4
	Pine grosbeak	0	0	0	0	2	0	4	0	0	0	0.6
	Chipping sparrow	0	0	0	0	2	0	2	0	0	2	0.6
	White-throated sparrow	4	2	7	6	4	6	5	4	6	4	4.8
Total Birds		53	54	59	62	72	55	80	56	47	72	61.0
Total Species		18	21	17	20	23	16	21	18	15	18	18.7

Table 8
Forest Bird Population Census
Methodology - 1 hour plot census
4 June - 16 June, 1979
Wawa, Ontario

Family	Species	June 4	June 5	June 6	June 7	June 8	June 9	June 11	June 12	June 14	June 16	Daily Avg
Tetraonidae	Ruffed grouse	0	0	2	0	1	0	0	0	0	0	0.3
Picidae	Common flicker	3	0	1	2	0	1	0	1	1	2	1.1
	Yellow-bellied sapsucker	2	0	1	1	1	2	3	1	0	1	1.2
Tyrannidae	Yellow-bellied flycatcher	1	2	0	1	0	0	0	0	0	0	0.4
	Least flycatcher	15	6	5	10	4	4	9	6	2	8	6.9
Corvidae	Gray jay	0	0	0	0	0	0	0	0	0	1	0.1
	Blue jay	0	2	0	0	0	0	0	0	0	0	0.2
Paridae	Black-capped chickadee	4	5	0	1	0	1	4	1	1	0	1.7
	Boreal chickadee	0	0	0	2	0	0	0	0	0	0	0.2
Sittidae	Red-breasted nuthatch	0	2	0	2	0	0	4	2	0	0	1.0
Troglodytidae	Winter wren	2	2	2	2	0	2	0	0	0	0	1.0
Mimidae	Catbird	0	0	2	0	2	2	2	0	0	0	0.8
Turdidae	American robin	0	0	0	0	0	0	2	0	0	2	0.4
	Swainson's thrush	2	3	2	2	2	2	1	3	3	11	3.1
	Veery	1	0	0	0	0	0	0	0	0	0	0.1
Sylviidae	Ruby-crowned kinglet	4	0	0	4	2	0	2	2	0	6	2.0
Vireonidae	Solitary vireo	5	4	2	4	0	0	0	0	0	0	1.5
	Red-eyed vireo	0	0	0	0	0	0	8	2	0	0	1.0
	Philadelphia vireo	0	0	0	0	4	4	2	4	10	10	3.4

Table 8 cont'd
Forest Bird Population Census
Methodology - 1 hour plot census
4 June - 16 June, 1979
Wawa, Ontario

Family	Species	June 4	June 5	June 6	June 7	June 8	June 9	June 11	June 12	June 14	June 16	Dail Avg
Parulidae	Black-and-white warbler	0	6	4	2	4	2	2	4	0	6	3.0
	Tennessee warbler	10	6	8	14	7	0	0	0	4	2	5.1
	Nashville warbler	4	2	0	2	2	2	0	0	5	2	1.9
	Magnolia warbler	18	6	10	8	12	2	7	4	4	8	7.9
	Cape May warbler	0	0	2	2	2	0	0	0	0	0	0.6
	Yellow-rumped warbler	2	0	2	2	0	0	0	0	0	0	0.6
	Black-throated green warbler	16	2	2	4	2	4	2	2	0	0	3.4
	Blackburnian warbler	8	6	2	4	6	2	2	2	4	4	4.0
	Chestnut-sided warbler	9	13	7	16	16	14	11	14	12	8	12.0
	Bay-breasted warbler	26	10	2	12	6	8	8	8	10	18	10.8
	Ovenbird	4	2	2	4	2	6	4	2	2	0	2.8
	Mourning warbler	6	0	2	4	3	6	0	2	2	4	2.9
	Canada warbler	0	2	2	3	0	4	0	0	0	8	1.9
	American redstart	20	10	5	10	6	10	7	9	6	9	9.2
Fringillidae	Purple finch	0	0	0	0	0	0	0	4	0	6	1.0
	Pine grosbeak	0	0	2	0	0	0	0	2	0	0	0.4
	Chipping sparrow	0	2	0	0	2	2	4	6	0	4	2.0
	White-throated sparrow	6	6	12	11	10	5	6	6	6	4	7.2
Total Birds		168	99	81	129	96	85	90	87	72	124	103.1
Total Species		22	21	23	26	21	21	20	22	15	21	21.2

APPENDIX III

Comparison of breeding territories of selected bird species as delineated by various census methods.

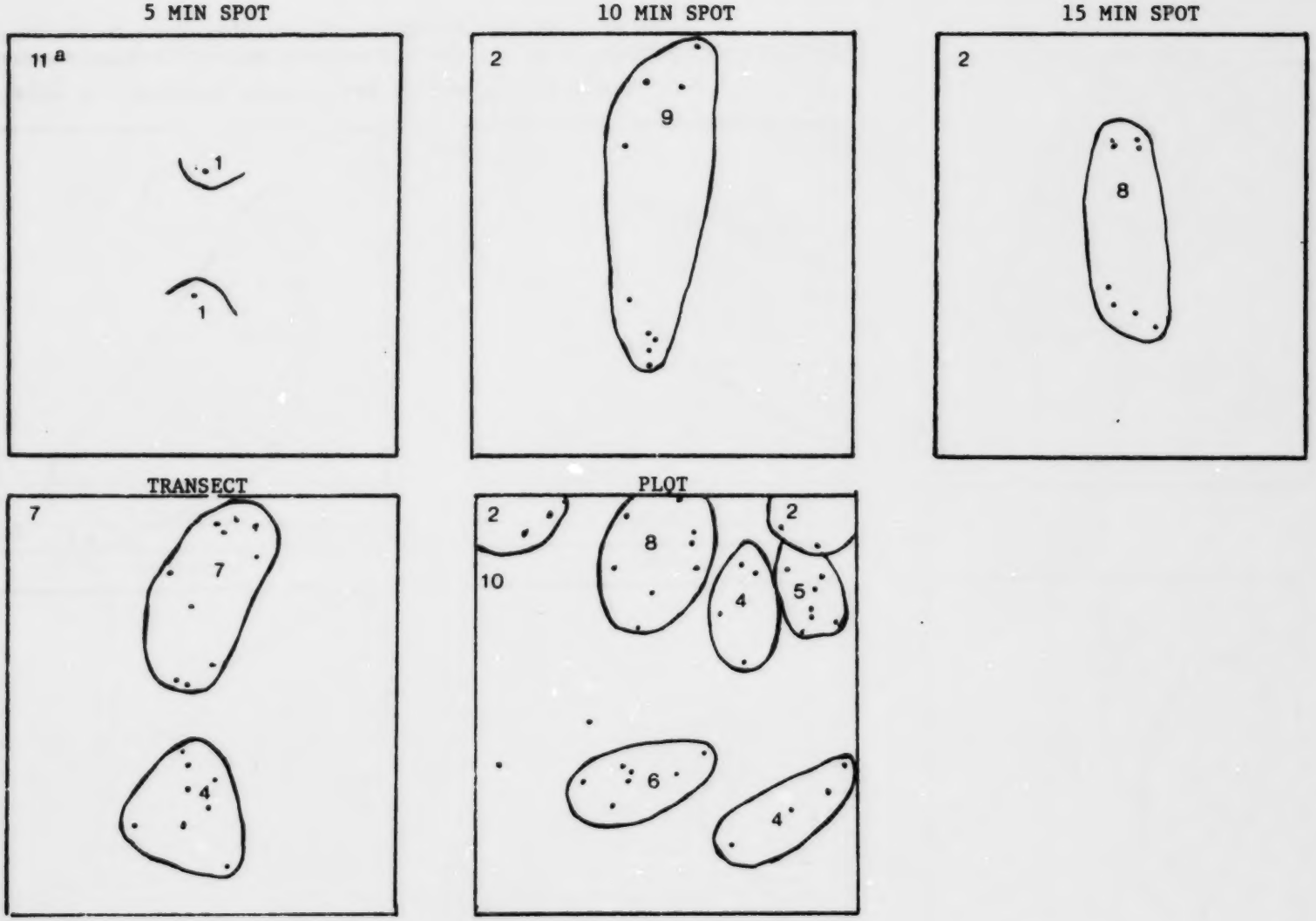

Figure 1. Breeding territories of the Least flycatcher.

Numbers within circles represent number of days recorded in territory.
[a] Number of days required to delineate the territories.

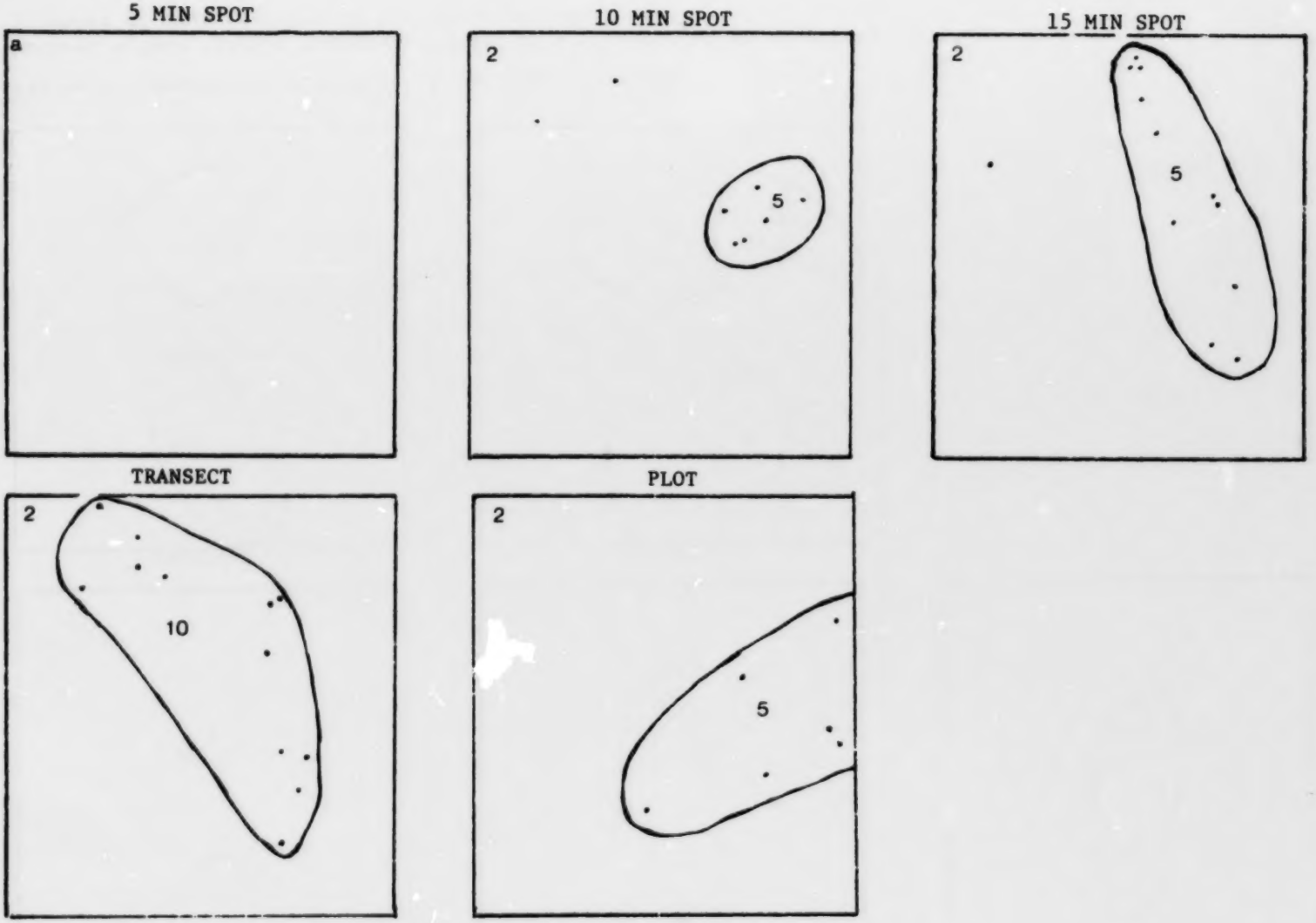

Figure 2. Breeding territories of the Winter wren.

Numbers within circles represent number of days recorded in territory.
[a] Number of days required to delineate the territories.

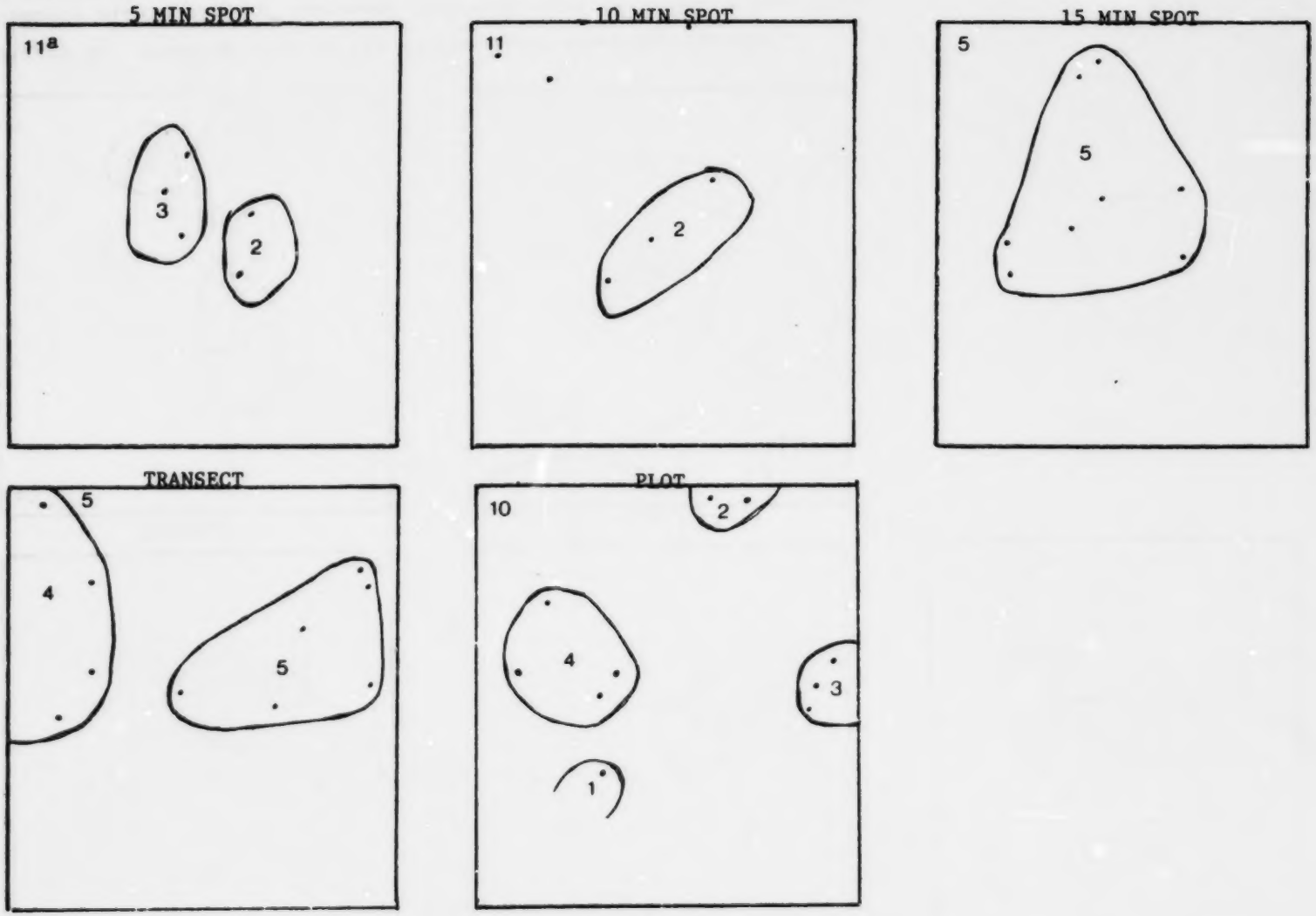

Figure 3. Breeding territories of the Ruby-crowned Kinglet.

Numbers within circles represent number of days recorded in territory.
[a] Number of days required to delineate the territories.

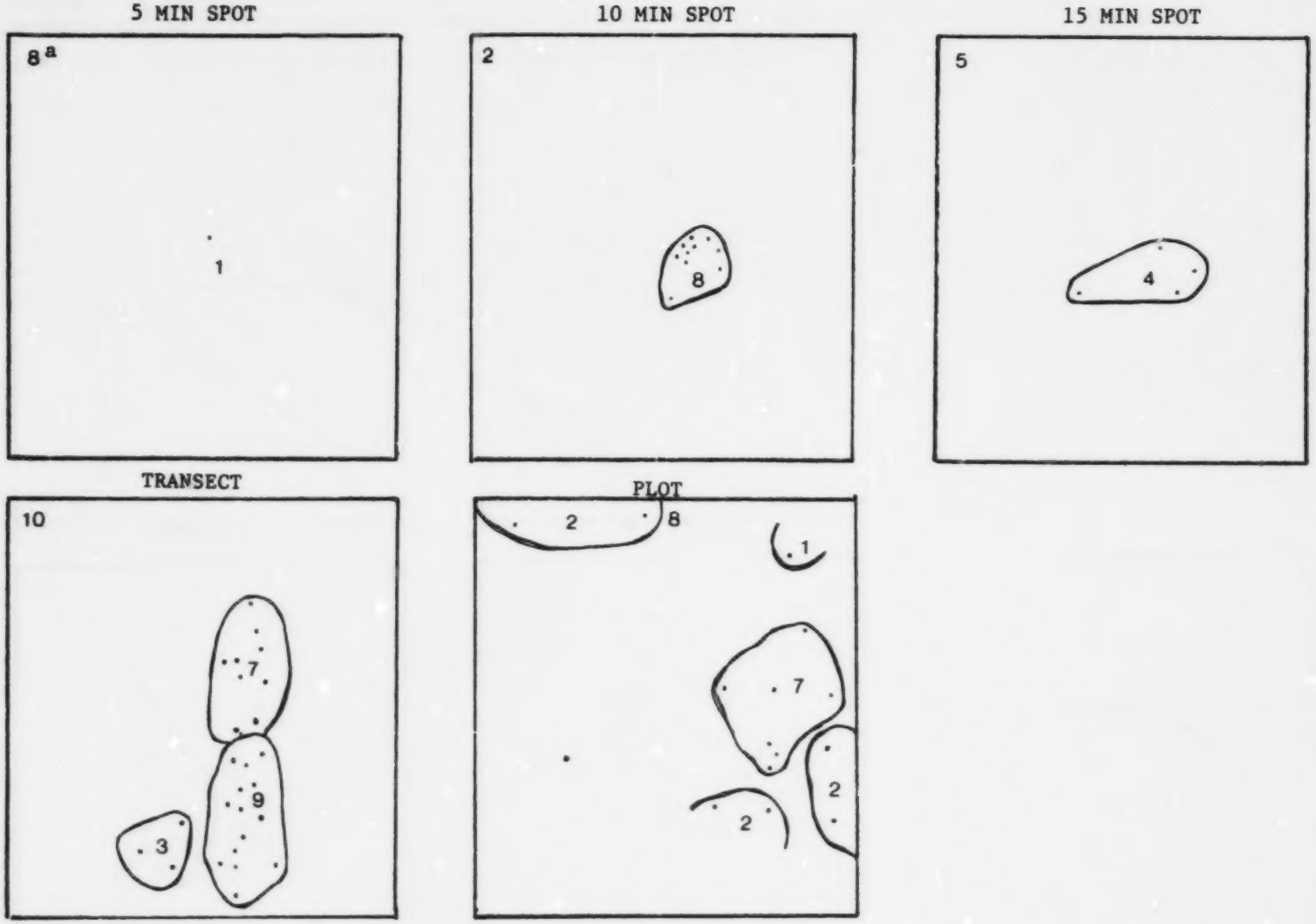

Figure 4. Breeding territories of the Black-and-white Warbler.

Numbers within circles represent number of days recorded in territory.
[a] Number of days required to delineate the territories.

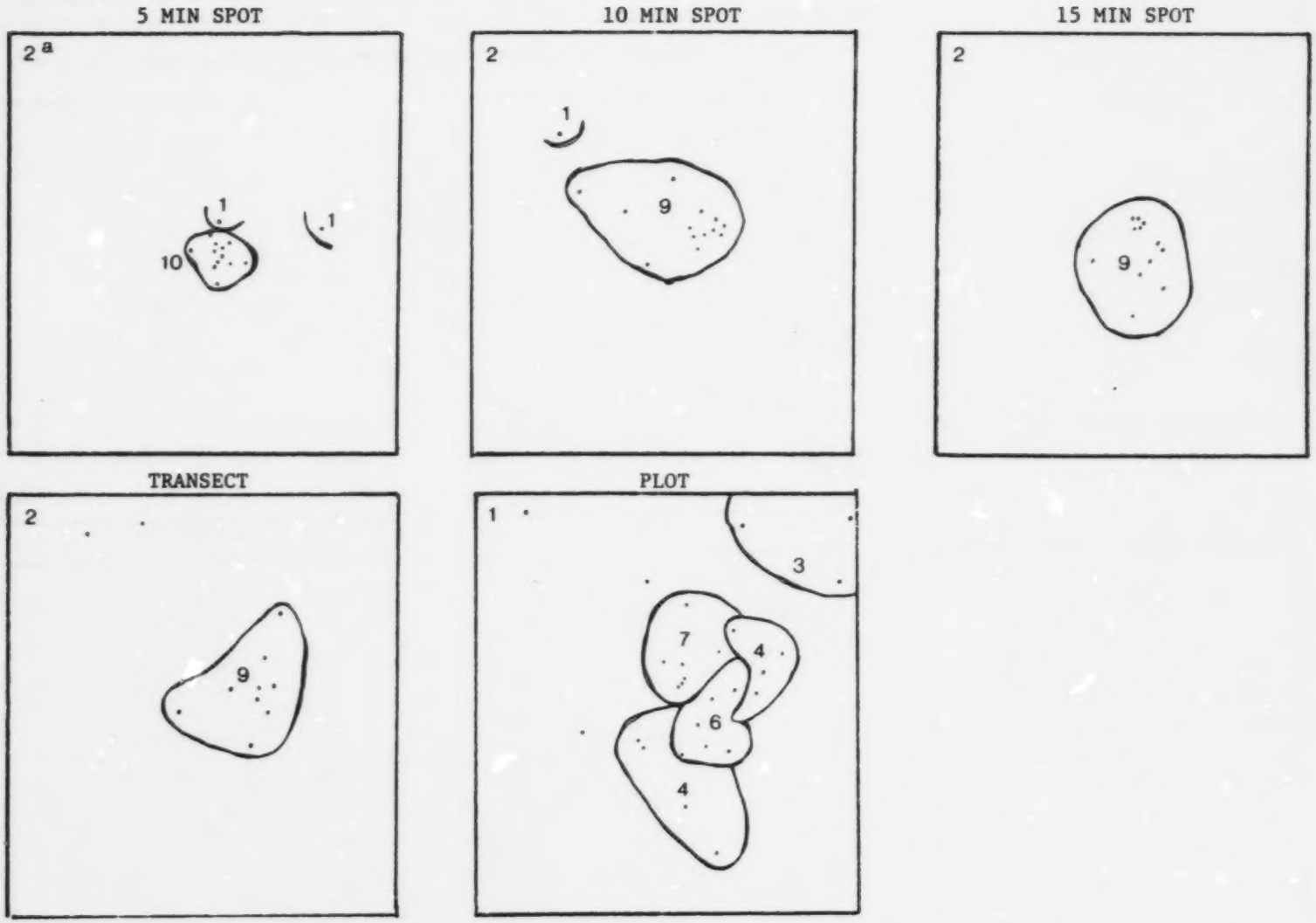

Figure 5. Breeding territories of the Tennessee warbler.

Numbers within circles represent number of days recorded in territory.
[a] Number of days required to delineate the territories.

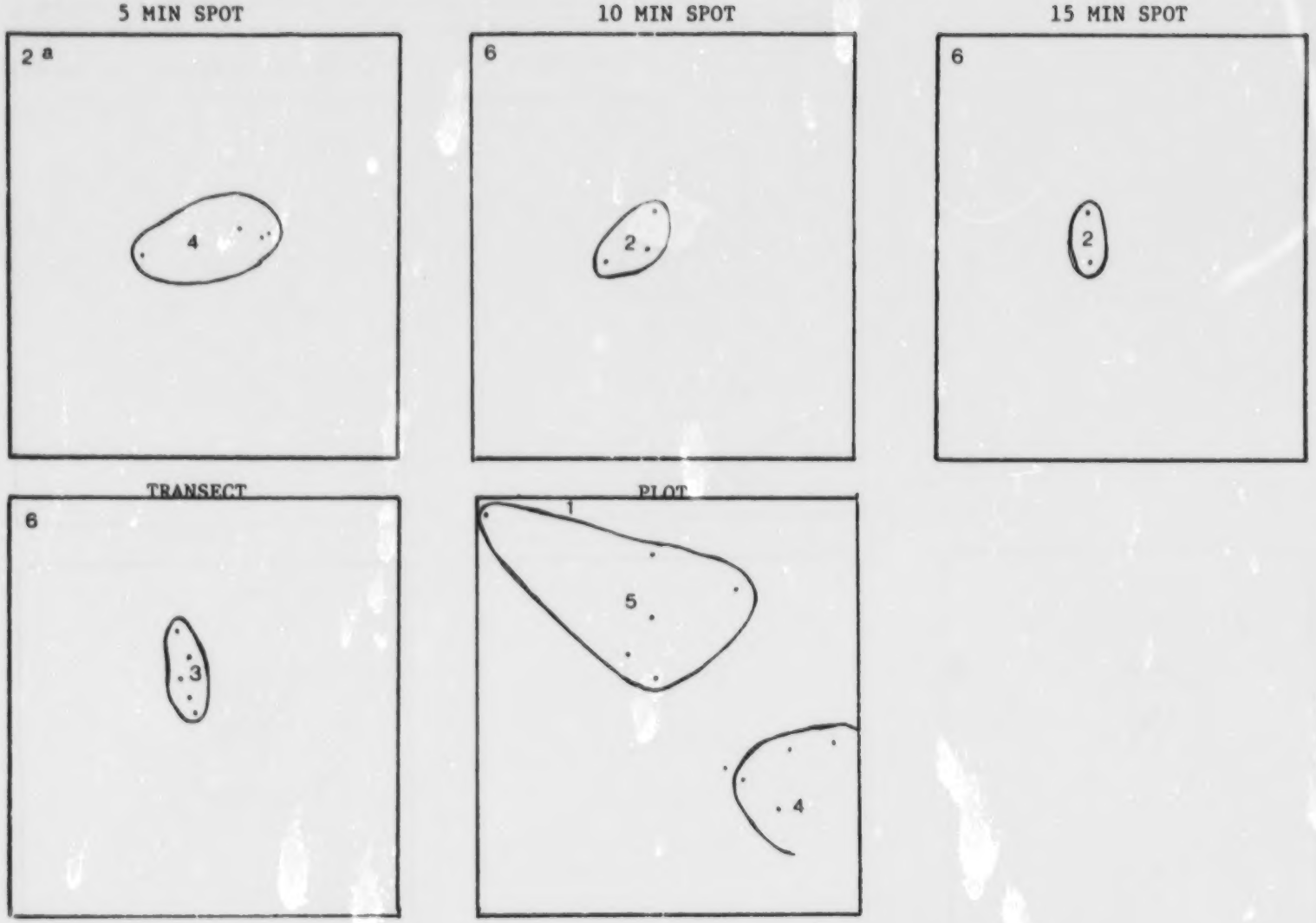

Figure 6. Breeding territories of the Nashville warbler.

Numbers within circles represent number of days recorded in territory.
[a] Number of days required to delineate the territories.

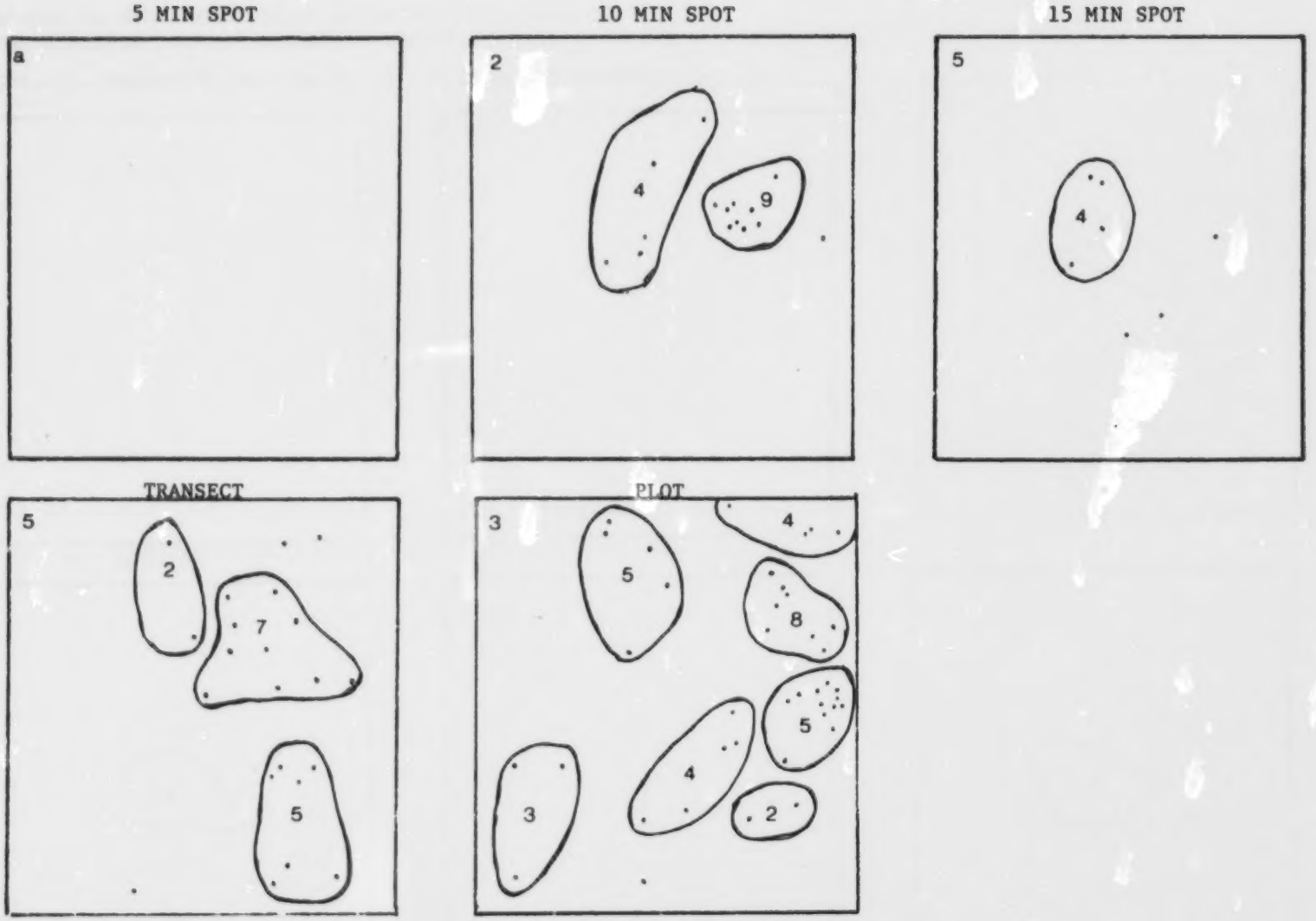

Figure 7. Breeding territories of the Magnolia warbler.

Numbers within circles represent number of days recorded in territory.
[a] Number of days required to delineate the territories.

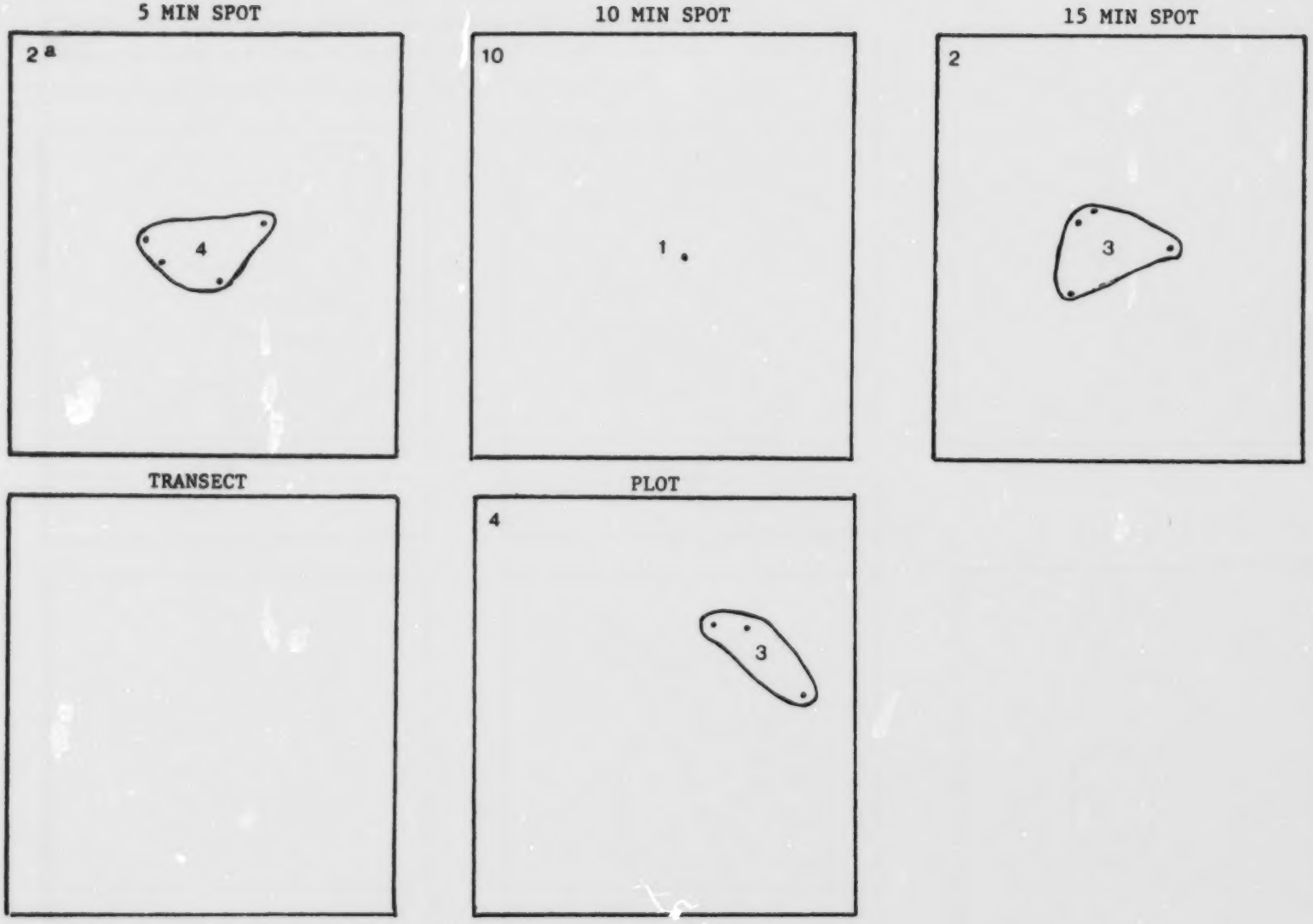

Figure 8. Breeding territories of the Cape May Warbler.

Numbers within circles represent number of days recorded in territory.
[a] Number of days required to delineate the territories.

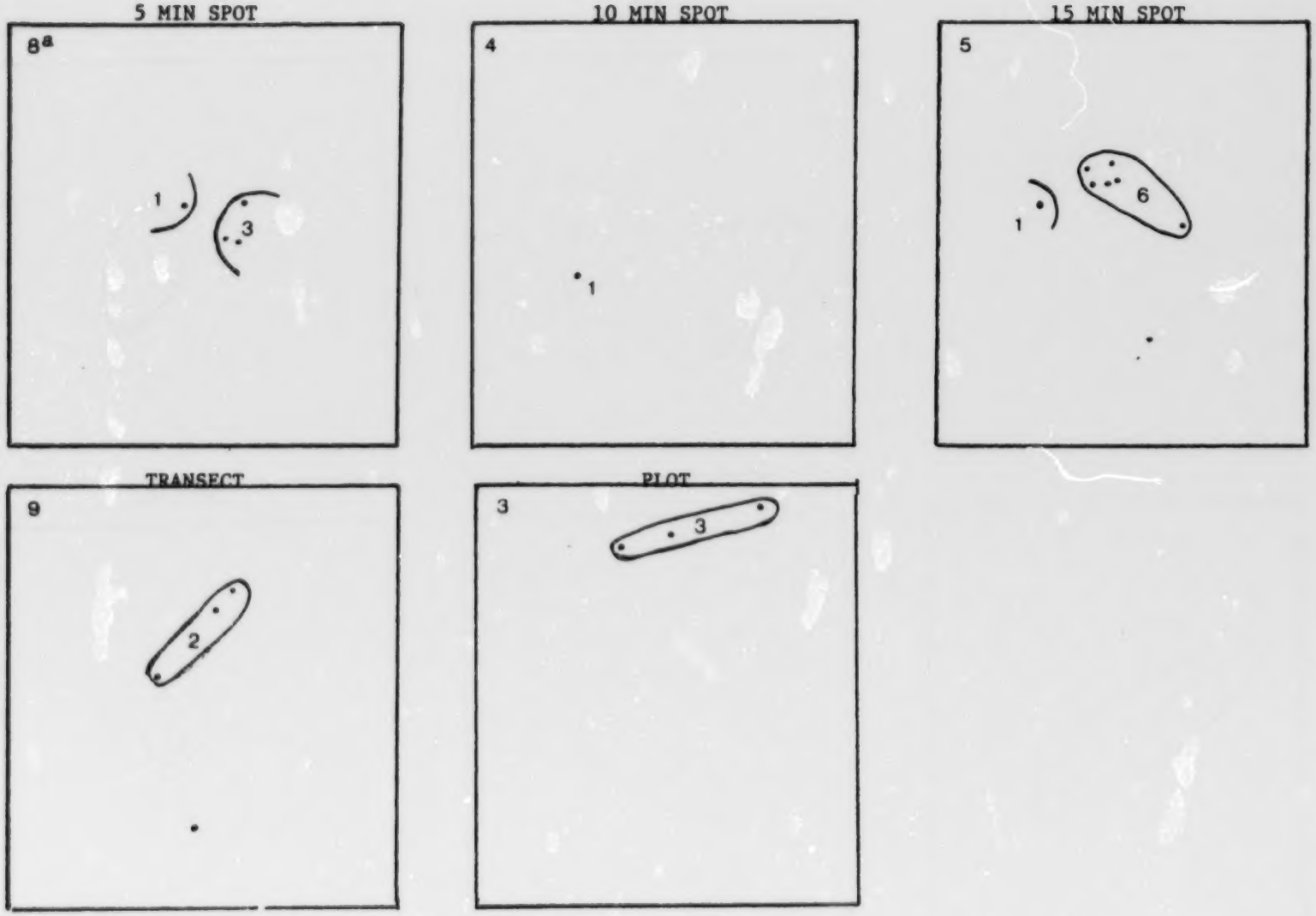

Figure 9. Breeding territories of the Yellow-rumped warbler.

Numbers within circles represent number of days recorded in territory.
[a] Number of days required to delineate the territories.

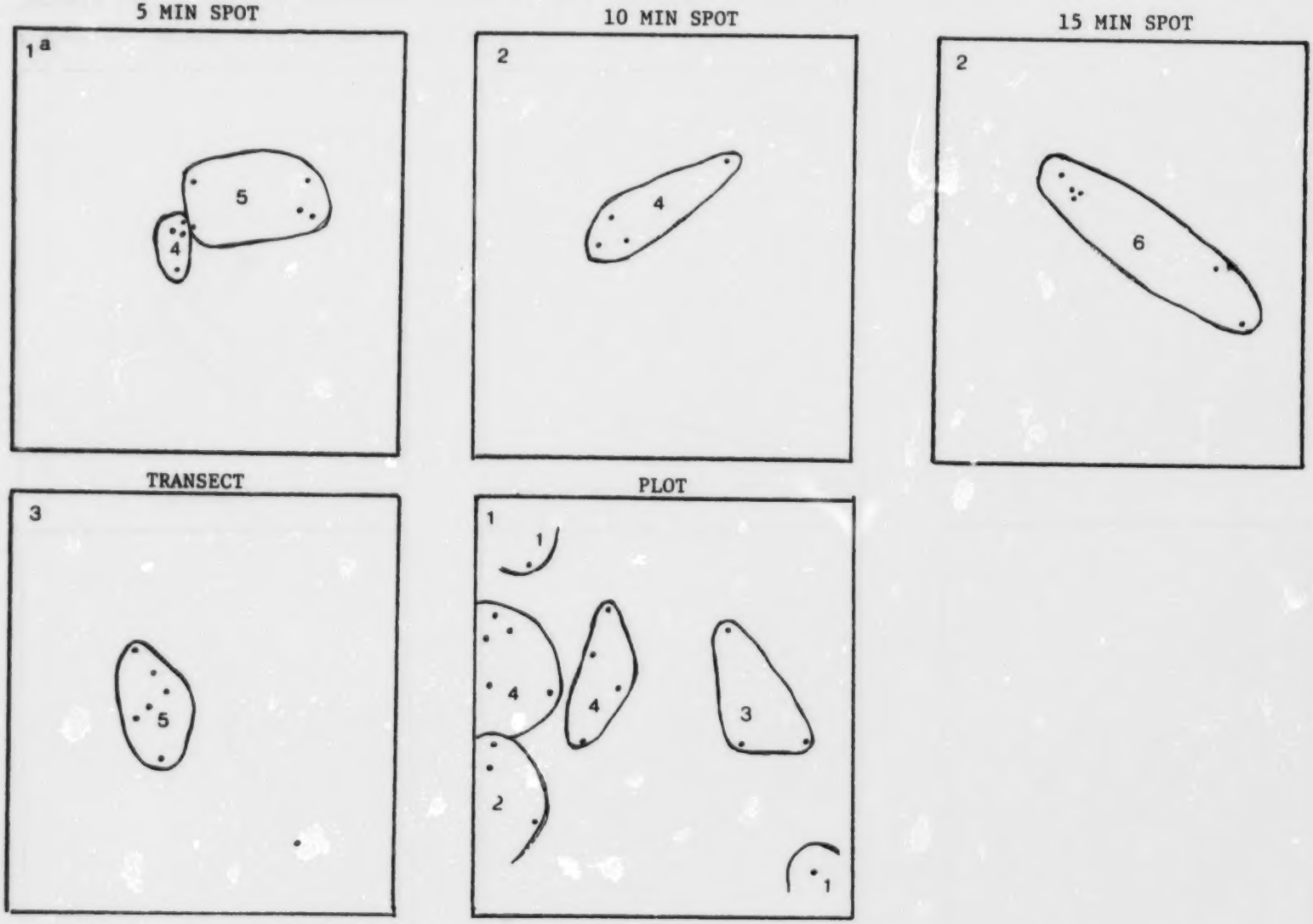

Figure 10. Breeding territories of the Black-throated green warbler.

Numbers within circles represent number of days recorded in territory.
[a] Number of days required to delineate the territories.

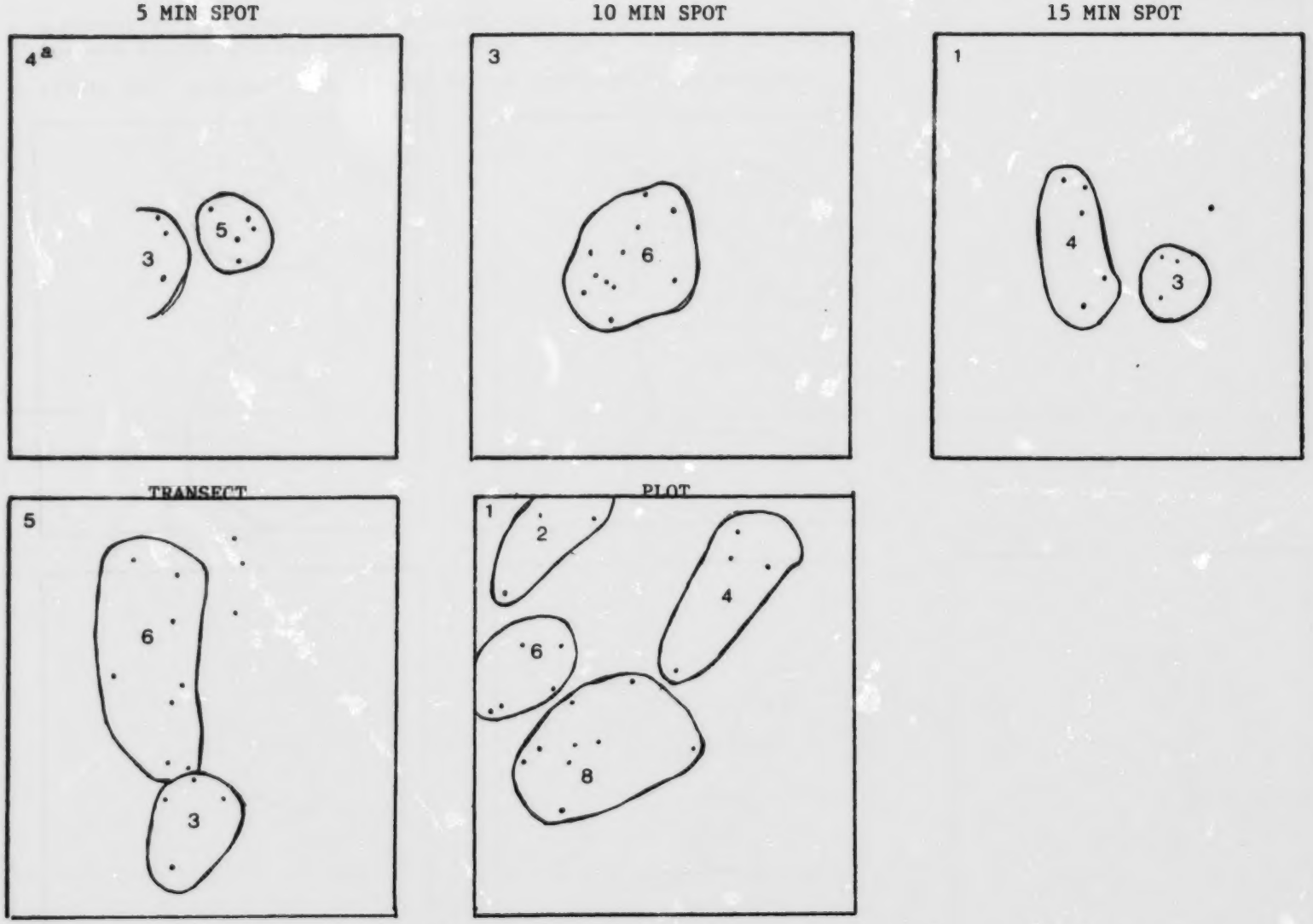

Figure 11. Breeding territories of the Blackburnian warbler.

Numbers within circles represent number of days recorded in territory.
[a] Number of days required to delineate the territories.

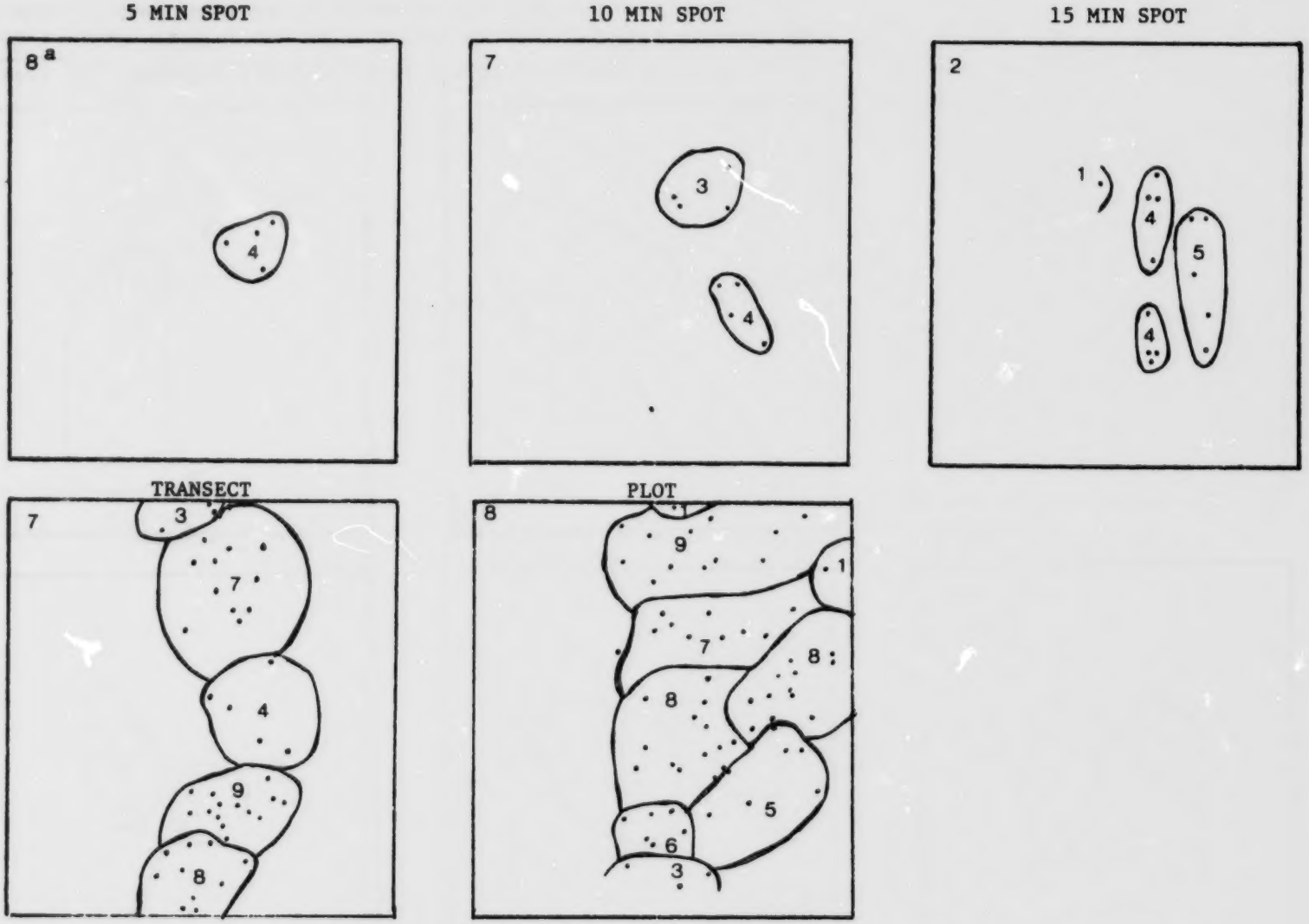

Figure 12. Breeding territories of the Chestnut-sided warbler.

Numbers within circles represent number of days recorded in territory.
[a] Number of days required to delineate the territories.

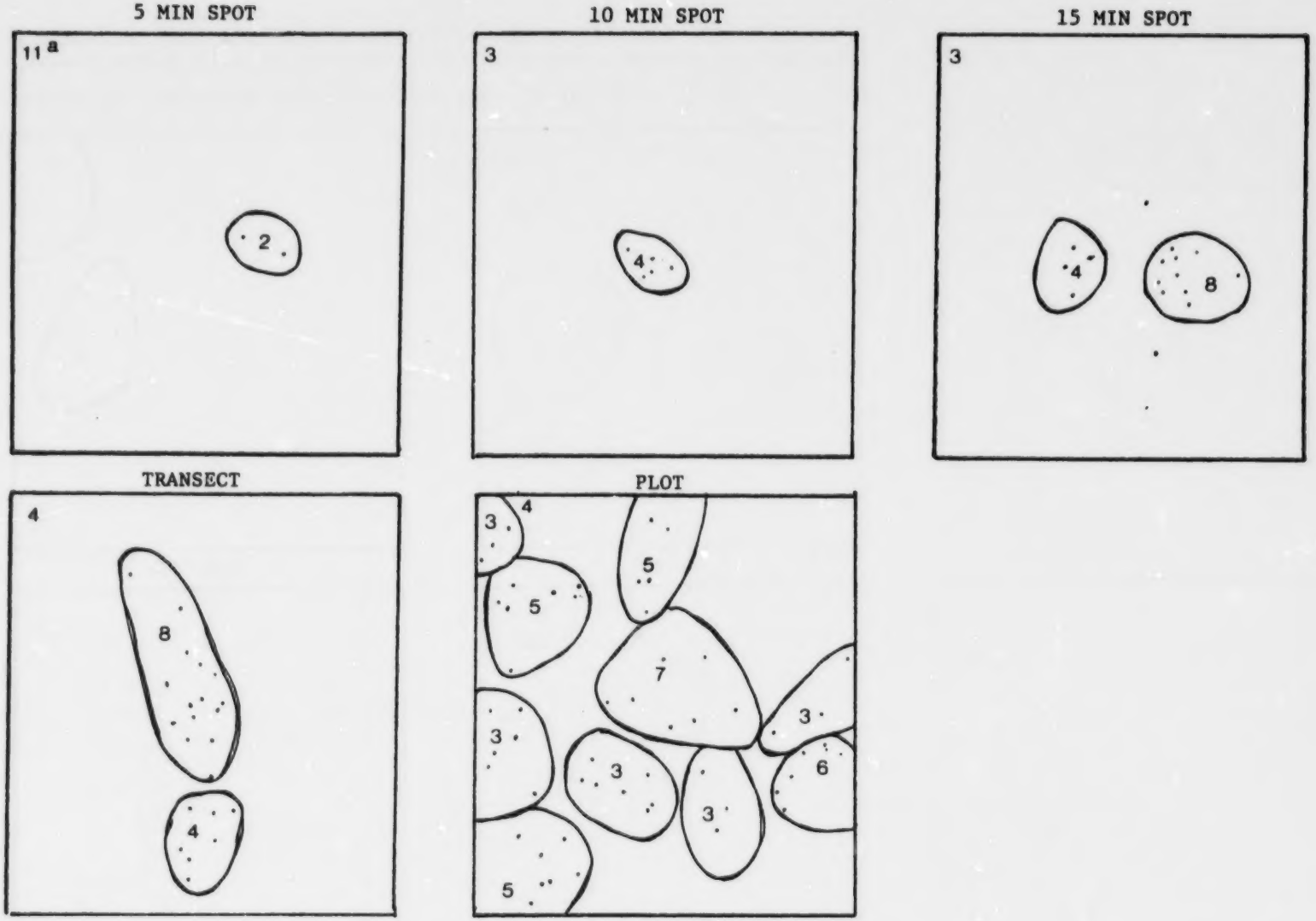

Figure 13. Breeding territories of the Bay-breasted warbler.

Numbers within circles represent number of days recorded in territory.
[a] Number of days required to delineate the territories.

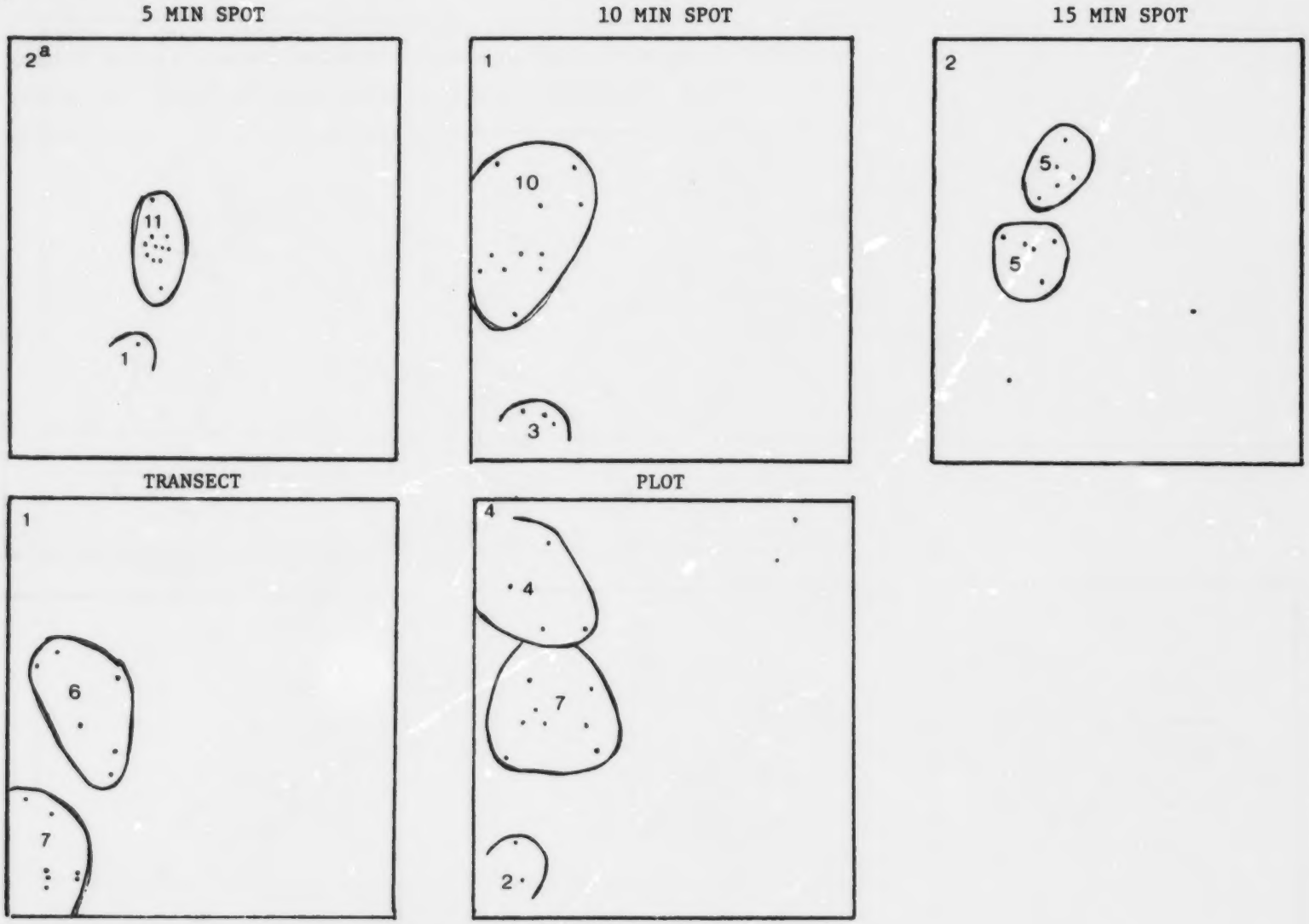

Figure 14. Breeding territories of the Ovenbird.

Numbers within circles represent number of days recorded in territory.
[a] Number of days required to delineate the territories.

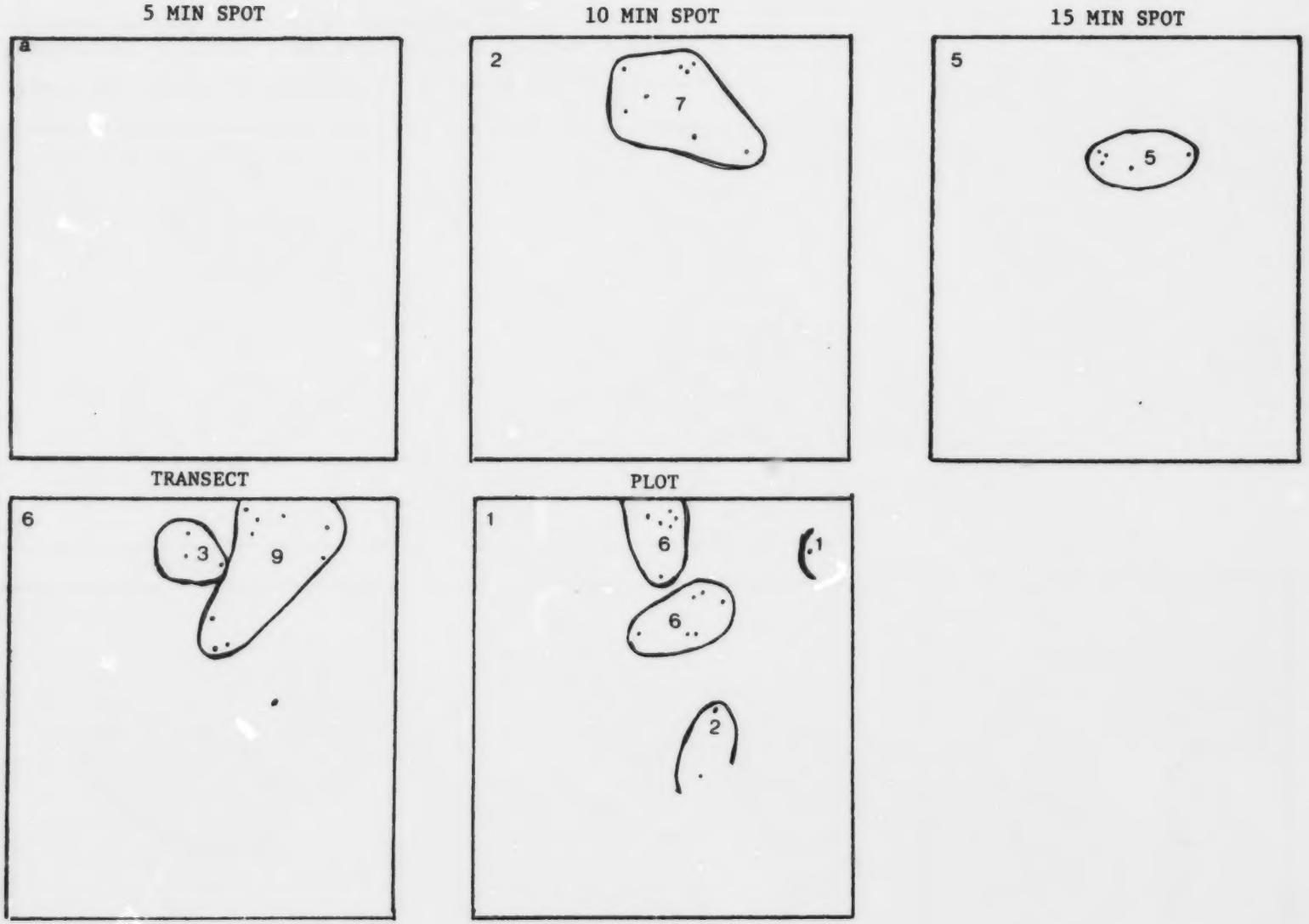

Figure 15. Breeding territories of the Mourning warbler.

Numbers within circles represent number of days recorded in territory.
[a] Number of days required to delineate the territories.

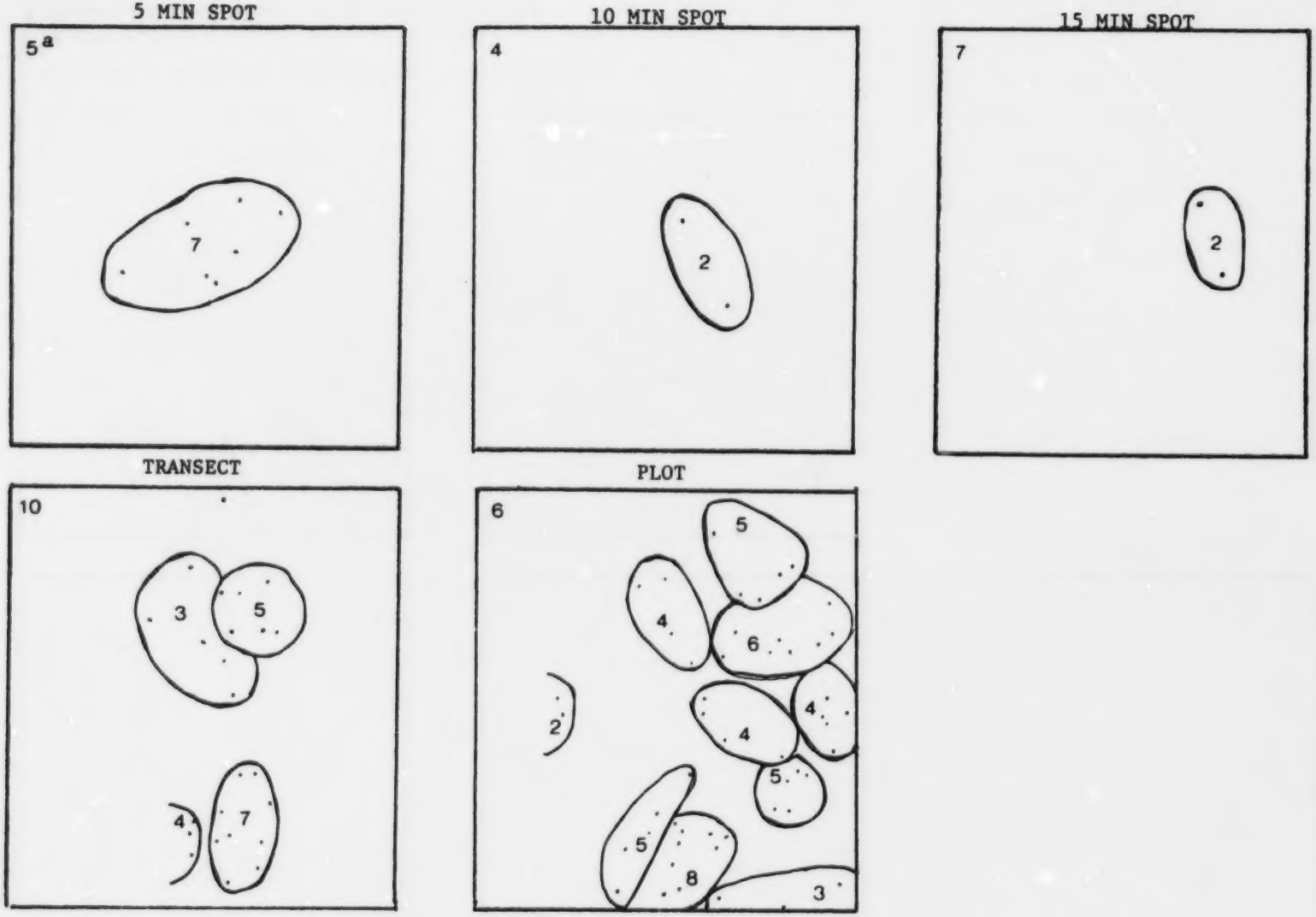

Figure 16. Breeding territories of the American redstart.

Numbers within circles represent number of days recorded in territory.
[a] Number of days required to delineate the territories.

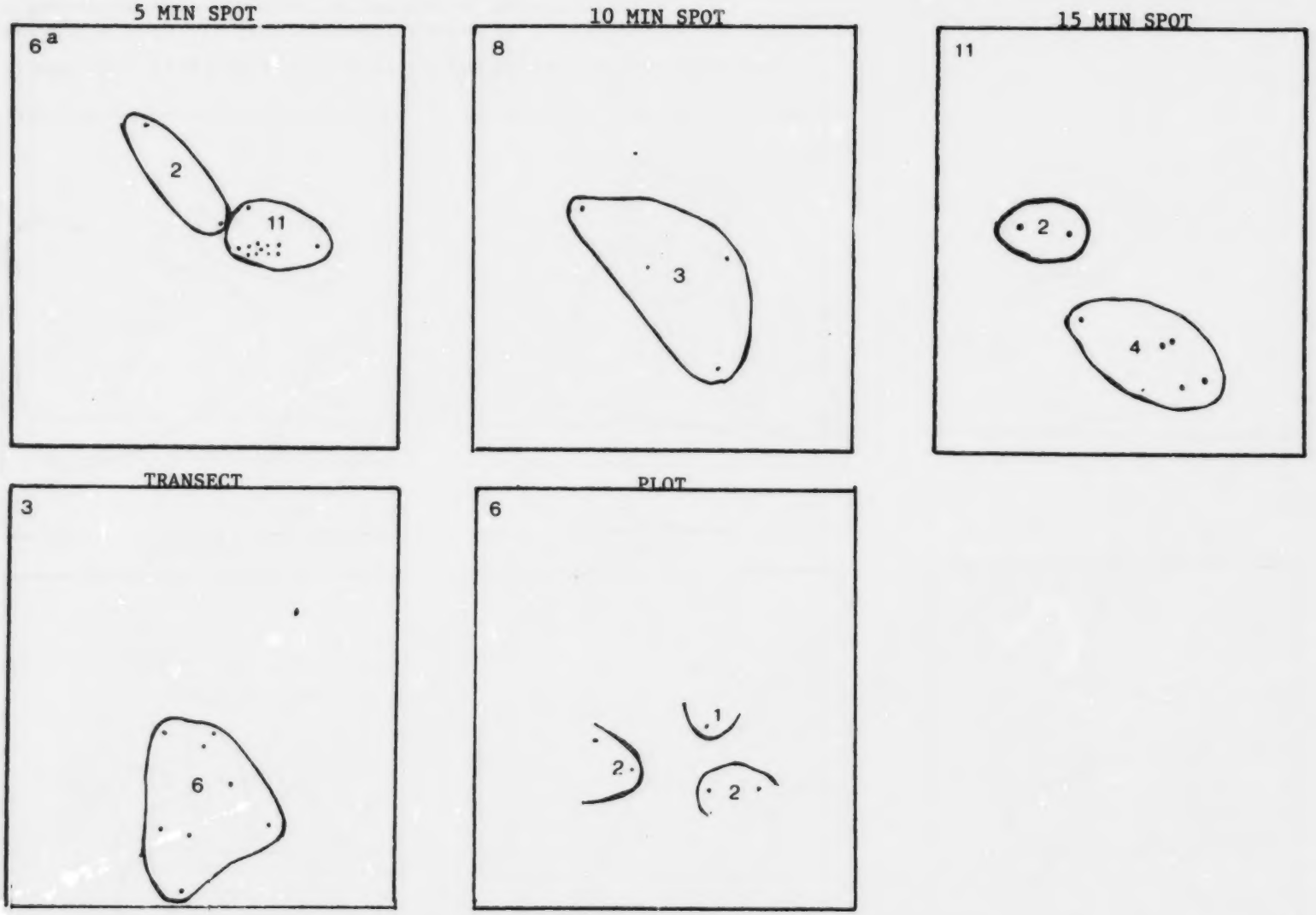

Figure 17. Breeding territories of the Purple finch.

Numbers within circles represent number of days recorded in territory.
[a] Number of days required to delineate the territories.

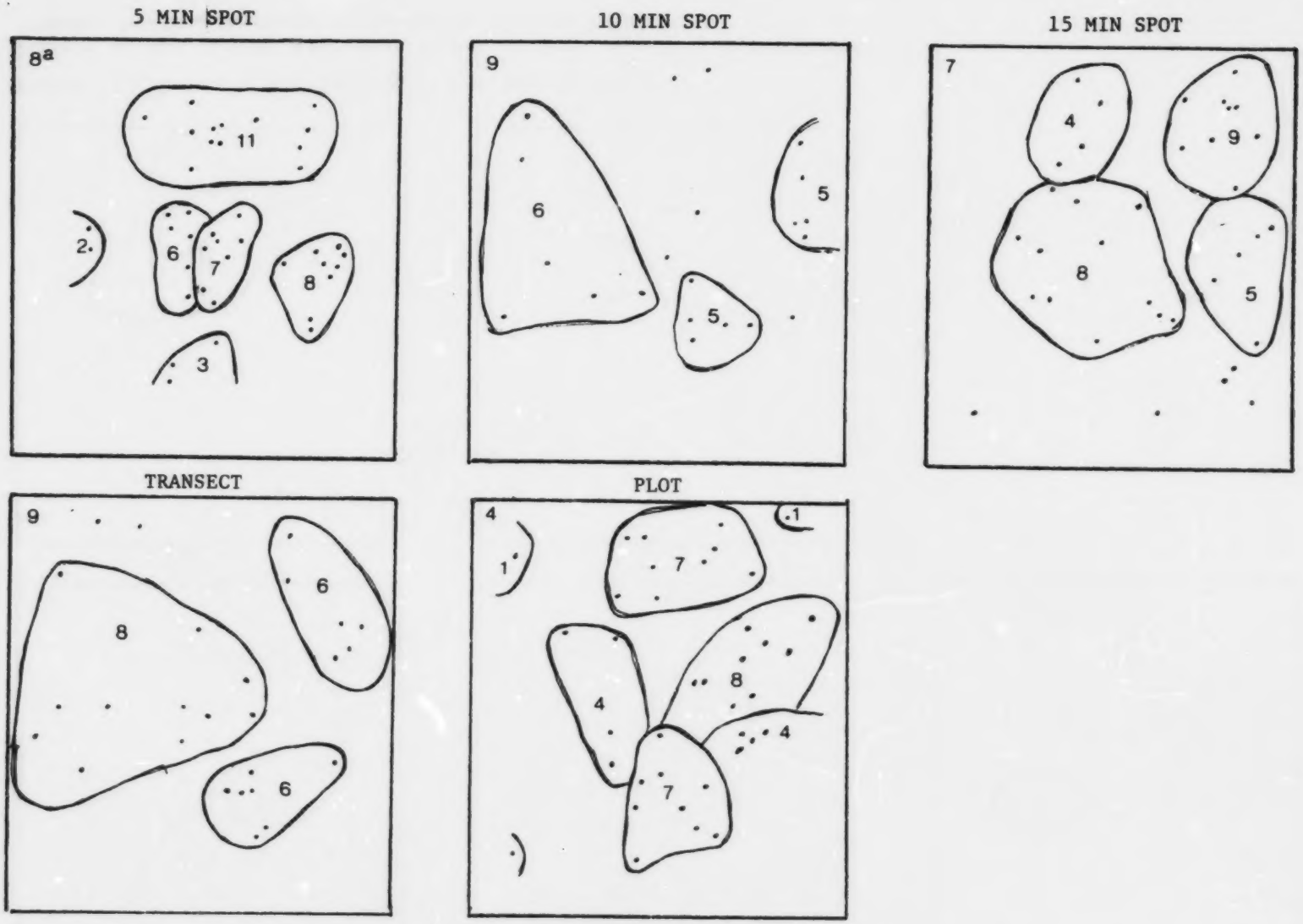

Figure 18. Breeding territories of the White-throated sparrow.

Numbers within circles represent number of days recorded in territory.
[a] Number of days required to delineate the territories.

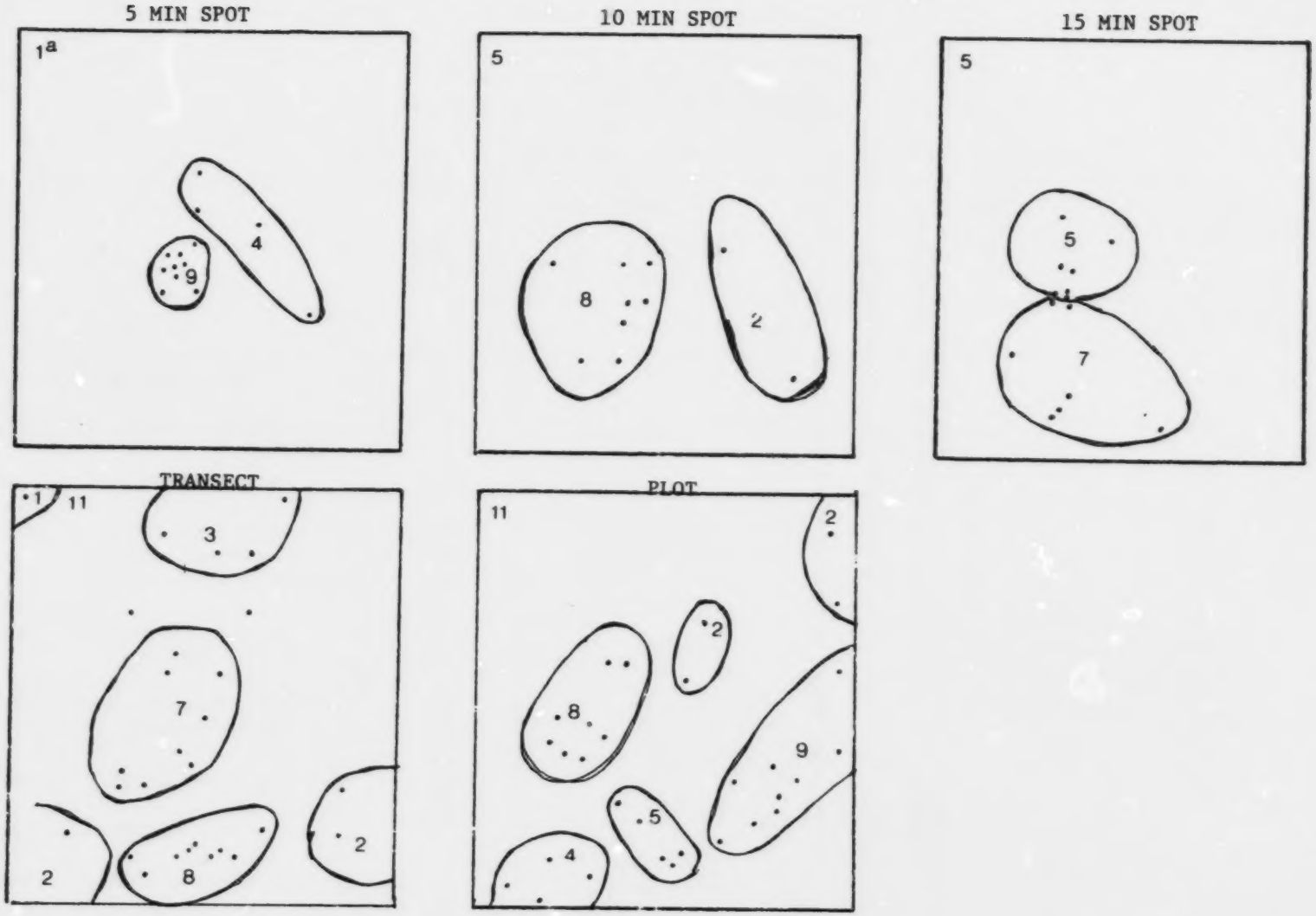

Figure 19. Breeding territories of Vireonidae (Red-eyed, solitary and Philadelphia combined).

Numbers within circles represent number of days recorded in territory.
[a] Number of days required to delineate the territories.

APPENDIX IV

Comparison of the population structure of bird communities censused with replications of a 10 minute spot conducted over 5 days to the same number of spot censuses conducted within 1 day

Table 1
Forest Bird Population Census
Ice Water Creek Research Area, Ontario
Site - 1
26-30 May, 1980

		Point census						Point census					
		May 26	May 27	May 28	May 29	May 30		May 29	May 29	May 29	May 29	May 29	
Family	Species	1	2	3	4	5	Avg	1	2	3	4	5	Avg
Tetraonidae	Ruffed grouse	0	2	2	0	2	1.2	0	0	0	0	0	0.0
Trochilidae	Ruby-throated hummingbird	0	1	0	0	0	0.2	0	0	0	0	1	0.2
Picidae	Hairy woodpecker	0	0	0	0	0	0.0	1	0	0	0	0	0.2
Tyrannidae	Great Crested flycatcher	0	0	0	2	0	0.4	2	2	2	0	0	1.2
	Least flycatcher	0	2	0	2	0	0.8	2	2	2	2	0	1.6
	Olive-sided flycatcher	0	0	0	0	0	0.0	0	0	0	0	2	0.4
Corvidae	Gray jay	0	0	0	0	0	0.0	2	0	0	0	0	0.4
	Blue jay	0	2	2	0	0	0.8	0	0	0	0	0	0.0
Paridae	Black-capped chickadee	1	2	1	0	0	0.8	0	0	1	0	0	0.2
	Boreal chickadee	0	0	0	0	0	0.0	2	0	0	0	0	0.4
Sittidae	Red-breasted nuthatch	0	0	0	0	0	0.0	0	0	2	0	0	0.4
Mimidae	Catbird	0	0	0	0	2	0.4	0	0	0	0	0	0.0
Turdidae	American robin	1	2	2	2	0	1.4	2	2	3	0	0	1.4
	Hermit thrush	0	0	6	2	4	2.4	6	2	5	0	0	2.6
	Swainson's thrush	0	0	0	0	2	0.4	0	0	0	0	0	0.0
Vireonidae	Solitary vireo	0	2	0	0	0	0.4	0	0	0	0	0	0.0
	Red-eyed vireo	2	0	2	0	0	0.8	2	0	2	2	2	1.6
	Philadelphia vireo	2	0	2	0	0	0.8	0	0	0	0	0	0.0

Table 1 (concluded)
Forest Bird Population Census
Ice Water Creek Research Area, Ontario
Site - 1
26-30 May, 1980

		Point census						Point census					
		May 26	May 27	May 28	May 29	May 30		May 29	May 29	May 29	May 29	May 29	
Family	Species	1	2	3	4	5	Avg	1	2	3	4	5	Avg
Parulidae	Black-and-white warbler	0	2	0	0	0	0.4	0	0	0	0	0	0.0
	Tennessee warbler	0	0	0	2	0	0.4	2	2	2	2	2	2.0
	Nashville warbler	4	6	7	8	6	6.2	6	8	6	5	4	5.8
	Yellow-rumped warbler	0	0	0	0	0	0.0	0	0	2	0	0	0.4
	Chestnut-sided warbler	2	5	0	4	6	3.4	4	4	4	2	1	3.0
	Ovenbird	0	0	4	2	2	1.6	2	2	4	2	0	2.0
	Mourning warbler	2	2	0	0	0	0.8	2	0	0	0	0	0.4
	Common yellowthroat	0	5	1	2	2	2.0	3	2	3	4	1	2.6
	Canada warbler	0	0	0	0	0	0.0	0	0	2	0	0	0.4
	American redstart	0	4	2	0	0	1.2	0	0	0	0	0	0.0
Fringillidae	Rose-breasted grosbeak	2	4	2	2	4	2.8	2	2	4	2	0	2.0
	White-throated sparrow	2	6	4	6	6	4.8	7	6	11	4	7	7.0
Unidentified Birds		0	2	1	0	0	0.6	1	0	0	0	0	0.2
Total Birds		18	49	38	34	36	35.0	48	34	55	25	20	36.4

Table 2
Forest Bird Population Census
Ice Water Creek Research Area, Ontario
Site - 1
9 - 12 June, 1980

		Point Census					Point Census					
		June 9	June 10	June 11	June 12		June 12	June 12	June 12	June 12	June 12	
Family	Species	1	2	3	4	Avg	1	2	3	4	5	Avg
Gaviidae	Common loon	0	0	0	0	0.0	0	0	0	1	0	0.2
Tetraonidae	Ruffed grouse	2	2	2	2	2.0	0	2	0	2	2	1.2
Tyrannidae	Great crested flycatcher	0	0	0	0	0.0	0	0	2	2	2	1.2
	Olive-sided flycatcher	0	0	4	0	1.0	0	0	0	0	0	0.0
	Least flycatcher	0	0	0	0	0.0	0	0	0	0	2	0.4
Sittidae	Red-breasted nuthatch	0	2	0	0	0.5	0	0	0	2	2	0.8
Mimidae	Catbird	0	0	2	2	1.0	0	2	0	0	0	0.4
Turdidae	American robin	0	0	2	0	0.5	0	0	2	0	0	0.4
	Wood thrush	0	0	0	4	1.0	4	4	0	2	4	1.2
	Hermit thrush	0	0	0	0	0.0	4	0	0	2	0	1.2
	Veery	0	0	0	0	0.0	0	0	0	2	0	0.4
Vireonidae	Red-eyed vireo	2	0	2	2	1.5	0	2	2	2	2	1.6
Parulidae	Black-and-white warbler	2	0	0	0	0.0	0	0	2	0	0	0.4
	Nashville warbler	4	8	2	4	4.5	2	4	4	0	6	3.2
	Black-throated blue warbler	0	2	0	0	0.5	0	0	0	0	0	0.0
	Blackburnian warbler	0	0	0	0	0.0	0	0	2	0	0	0.4
	Chestnut-sided warbler	2	2	4	6	3.5	6	6	4	4	4	4.8
	Ovenbird	2	0	4	2	2.0	6	2	2	2	4	3.2
	Mourning warbler	0	0	0	0	0.0	0	0	0	2	0	0.4
	Common yellowthroat	0	2	0	0	0.5	0	0	2	0	0	0.4

Table 2 (concluded)
Forest Bird Population Census
Ice Water Creek Research Area, Ontario
Site - 1
9 - 12 June, 1980

		Point Census					Point Census					
		June 9	June 10	June 11	June 12		June 12	June 12	June 12	June 12	June 12	
Family	Species	1	2	3	4	Avg	1	2	3	4	5	Avg
Fringillidae	Rose-breasted grosbeak	0	8	4	6	4.5	10	6	2	6	8	6.4
	Evening grosbeak	4	0	0	0	1.0	0	0	0	0	0	0.0
	Chipping sparrow	0	0	2	0	0.5	0	0	0	0	0	0.0
	White-throated sparrow	2	4	6	6	4.5	6	6	4	6	8	6.0
Unidentified Birds		1	1	1	3	1.5	2	3	1	0	2	1.6
Total Birds		19	31	35	37	30.5	40	37	29	35	46	37.4

Table 3
Forest Bird Population Census
Ice Water Creek Research Area, Ontario
Site - 1
23-27 June, 1980

		Point census						Point census					
		June 23	June 24	June 25	June 26	June 27		June 26	June 26	June 26	June 26	June 26	
Family	Species	1	2	3	4	5	Avg	1	2	3	4	5	Avg
Tetraonidae	Ruffed grouse	0	0	2	0	0	0.4	0	0	0	0	0	0.0
Picidae	Pileated woodpecker	0	0	0	0	0	0.0	0	0	0	0	2	0.4
Tyrannidae	Alder flycatcher	0	0	0	0	0	0.0	0	0	0	0	2	0.4
Corvidae	Common crow	0	0	2	0	0	0.4	0	0	0	0	0	0.0
Sittidae	Red-breasted nuthatch	0	0	0	0	2	0.4	0	0	0	0	0	0.0
Troglodytidae	Winter wren	0	0	4	0	0	0.8	2	0	0	0	0	0.4
Mimidae	Catbird	0	2	2	0	0	0.8	0	0	4	0	0	0.8
Turdidae	Wood thrush	0	0	0	4	6	2.0	8	4	4	4	4	4.8
	Hermit thrush	4	4	4	0	2	2.8	2	0	2	4	4	2.4
	Swainson's thrush	0	0	2	2	2	1.2	0	2	0	0	0	0.4
	Veery	2	0	4	4	0	2.0	0	4	2	0	2	1.6
Vireonidae	Red-eyed vireo	2	2	2	2	2	2.0	2	2	2	2	2	2.0
Parulidae	Black-and-white warbler	0	0	0	2	0	0.4	0	2	2	0	0	0.8
	Nashville warbler	6	10	12	8	10	9.2	10	8	8	12	12	10.0
	Parula warbler	0	0	0	0	2	0.4	0	0	0	0	0	0.0
	Yellow warbler	0	0	0	2	0	0.4	0	2	0	0	0	0.4
	Chestnut-sided warbler	6	2	4	2	4	3.6	8	2	8	4	2	4.8
	Ovenbird	0	0	0	0	0	0.0	0	0	0	0	4	0.8
	Common yellowthroat	0	0	0	0	0	0.0	2	0	0	0	0	0.4
Fringillidae	Rose-breasted grosbeak	8	6	2	2	2	4.0	6	2	6	4	4	4.4
	White-throated sparrow	6	6	5	4	6	5.4	6	4	4	6	4	4.8
Unidentified Birds		2	1	5	1	0	1.8	2	1	3	2	0	1.6
Total Birds		36	33	50	33	38	38.0	48	33	45	38	42	41.2

Table 4
Forest Bird Population Census
Ice Water Creek Research Area, Ontario
Site - 1
7-11 July, 1980

		Point census						Point census					
		July 7	July 8	July 9	July 10	July 11		July 10	July 10	July 10	July 10	July 10	
Family	Species	1	2	3	4	5	Avg	1	2	3	4	5	Avg
Tyrannidae	Great crested flycatcher	0	0	0	2	4	1.2	0	2	2	2	0	1.2
Corvidae	Common raven	2	2	2	2	2	2.0	2	2	2	0	0	1.2
	Common crow	0	0	0	0	0	0.0	0	0	0	1	0	0.0
Sittidae	Red-breasted nuthatch	0	2	0	0	0	0.4	0	0	2	0	0	0.4
Troglodytidae	Winter wren	0	0	0	0	0	0.0	0	0	0	2	0	0.4
Mimidae	Catbird	0	0	0	0	0	0.0	0	0	4	0	2	1.2
Turdidae	Hermit thrush	2	2	4	6	6	4.0	6	6	4	6	6	5.6
	Swainson's thrush	1	0	0	0	2	0.6	0	0	0	0	0	0.0
	Veery	0	0	0	0	0	0.0	2	0	0	2	0	0.8
Bombycillidae	Cedar waxwing	0	0	0	0	0	0.0	0	0	0	2	0	0.4
Vireonidae	Red-eyed vireo	2	2	0	2	2	1.6	2	2	2	2	2	2.0
Parulidae	Black-and-white warbler	0	0	0	0	0	0.0	0	0	0	0	2	0.4
	Tennessee warbler	4	0	2	0	0	1.2	2	0	0	0	0	0.4
	Nashville warbler	12	10	8	6	10	9.2	6	6	8	4	6	6.0
	Yellow-rumped warbler	0	0	0	2	2	0.8	0	2	2	0	0	0.8
	Chestnut-sided warbler	2	2	2	4	0	2.0	2	4	2	4	6	3.6
	Mourning warbler	0	0	0	0	0	0.0	0	0	0	2	2	0.8
	American redstart	2	2	0	0	0	0.8	0	0	0	0	0	0.0
Fringillidae	Rose-breasted grosbeak	6	6	6	2	4	4.8	4	2	6	6	6	4.8
	White-throated sparrow	8	6	6	4	4	5.6	8	4	6	4	6	5.6
Unidentified Birds		2	1	1	3	2	1.8	2	3	2	3	0	2.0
Total Birds		43	35	31	33	38	36.0	36	33	42	40	38	37.8

Table 5
Forest Bird Population Census
Ice Water Creek Research Area, Ontario
Site - 2
26-30 May, 1980

		Point census						Point census					
		May 26	May 27	May 28	May 29	May 30		May 29	May 29	May 29	May 29	May 29	
Family	Species	1	2	3	4	5	Avg	1	2	3	4	5	Avg
Gaviidae	Common loon	0	0	1	0	0	0.2	0	0	0	0	0	0.0
Ardeidae	American bittern	0	0	0	0	0	0.0	2	0	0	0	0	0.4
Cuculidae	Black-billed cuckoo	0	0	0	0	0	0.0	0	0	0	2	0	0.4
Tyrannidae	Olive-sided flycatcher	0	0	0	0	0	0.0	2	0	0	0	0	0.4
Corvidae	Common crow	0	0	0	0	0	0.0	1	0	0	0	0	0.2
Paridae	Black-capped chickadee	0	0	0	2	0	0.4	0	2	0	0	0	0.4
Sittidae	Red-breasted nuthatch	2	4	4	4	4	3.6	0	4	4	4	4	3.2
Troglodytidae	Winter wren	0	0	0	2	0	0.4	0	2	0	2	0	0.8
Turdidae	American robin	0	0	2	0	2	0.8	0	0	2	0	0	0.4
	Wood thrush	0	0	0	2	0	0.4	0	2	2	0	0	0.8
	Hermit thrush	0	2	4	0	4	2.0	4	0	4	0	0	1.6
	Swainson's thrush	0	0	0	0	0	0.0	0	0	2	0	0	0.4
Sylviidae	Golden-crowned kinglet	0	0	0	0	0	0.0	2	0	2	0	0	0.8
	Ruby-crowned kinglet	2	0	0	0	2	0.8	2	0	2	0	2	1.2
Vireonidae	Red-eyed vireo	0	0	0	2	0	0.4	0	2	0	2	2	1.2
Parulidae	Black-and-white warbler	0	0	0	0	0	0.0	2	0	0	0	0	0.4
	Nashville warbler	0	0	0	2	0	0.4	4	2	2	2	0	2.0
	Cape May warbler	0	0	0	0	0	0.0	2	0	0	0	0	0.4
	Black-throated blue warbler	0	0	2	0	0	0.4	2	0	0	0	2	0.8
	Black-throated green Warbler	2	2	0	0	0	0.8	2	0	4	0	0	1.2

Table 5 (Concluded)
Forest Bird Population Census
Ice Water Creek Research Area, Ontario
Site - 2
26-30 May, 1980

		Point census						Point census					
		May 26	May 27	May 28	May 29	May 30		May 29	May 29	May 29	May 29	May 29	
Family	Species	1	2	3	4	5	Avg	1	2	3	4	5	Avg
Parulidae	Blackburnian warbler	4	6	2	6	2	4.0	5	6	6	2	4	4.6
	Chestnut-sided warbler	2	2	0	0	0	0.8	2	0	2	2	4	2.0
	Bay-breasted warbler	2	4	4	0	4	2.8	4	0	2	0	2	1.6
	Ovenbird	4	6	4	6	4	4.8	6	6	8	6	4	6.0
	Northern waterthrush	0	2	0	4	0	1.2	2	4	2	0	0	1.6
	Common yellowthroat	0	2	0	0	2	0.8	0	0	2	0	0	0.4
	American redstart	0	0	0	0	0	0.0	0	0	0	2	0	0.4
Icteridae	Brown-headed cowbird	0	0	0	0	0	0.0	2	0	0	0	0	0.4
Fringillidae	Rose-breasted grosbeak	2	0	2	2	2	1.6	2	2	2	4	0	2.0
	White-throated sparrow	2	1	4	2	2	2.2	5	2	0	2	2	2.2
Unidentified Birds		0	0	0	1	5	1.2	2	1	3	4	0	2.0
Total Birds		22	31	29	35	33	30.0	55	35	51	34	26	40.2

Table 6
Forest Bird Population Census
Ice Water Creek Research Area, Ontario
Site - 2
9 - 12 June, 1980

		Point Census					Point Census					
		June 9	June 10	June 11	June 12		June 12	June 12	June 12	June 12	June 12	
Family	Species	1	2	3	4	Avg	1	2	3	4	5	Avg
Tyrannidae	Great crested flycatcher	0	0	0	2	0.5	2	2	0	2	0	1.2
	Eastern phoebe	0	0	0	0	0.0	0	0	2	0	0	0.4
	Least flycatcher	0	0	0	0	0.0	0	0	2	0	2	0.8
	Eastern wood peewee	0	0	0	0	0.0	0	0	2	0	0	0.4
Corvidae	Blue jay	1	0	0	0	0.0	0	0	0	1	0	0.2
Paridae	Black-capped chickadee	0	2	0	0	0.5	0	0	2	0	0	0.4
Sittidae	Red-breasted nuthatch	2	0	0	2	1.0	0	2	2	2	0	1.2
Troglodytidae	Winter wren	2	4	4	4	3.5	4	4	2	2	0	2.4
Mimidae	Catbird	0	0	0	0	0.0	0	0	0	0	2	0.4
Turdidae	American robin	2	2	2	0	1.5	0	0	2	0	0	0.4
	Wood thrush	2	0	2	2	1.5	4	2	2	2	2	2.4
	Hermit thrush	0	6	2	2	2.5	2	2	2	4	2	2.4
	Swainson's thrush	0	0	2	2	1.0	2	2	0	2	0	1.2
	Veery	0	0	0	2	0.5	2	2	2	0	0	1.2
Sylviidae	Ruby-crowned kinglet	0	2	0	0	0.5	0	0	0	2	0	0.0
Parulidae	Tennessee warbler	2	0	0	0	0.5	0	0	0	0	0	0.0
	Nashville warbler	0	0	0	0	0.0	0	0	0	2	0	0.4
	Parula warbler	2	2	4	2	2.5	0	2	0	2	2	1.2
	Black-throated blue warbler	0	2	0	0	0.5	0	0	0	0	0	0.0
	Black-throated green warbler	0	0	0	2	0.5	0	2	2	0	0	0.8
	Blackburnian warbler	4	4	6	4	4.5	8	4	6	4	4	5.2
	Chestnut-sided warbler	2	0	2	4	2.0	2	4	0	2	0	1,6
	Bay-breasted warbler	0	2	0	2	1.0	2	2	2	2	2	2.0

Table 6 (concluded)
Forest Bird Population Census
Ice Water Creek Research Area, Ontario
Site - 2
9 - 12 June, 1980

		Point Census					Point Census					
		June 9	June 10	June 11	June 12		June 12	June 12	June 12	June 12	June 12	
Family	*Species*	1	2	3	4	Avg	1	2	3	4	5	Avg
Parulidae	Ovenbird	4	4	8	6	5.5	4	6	8	6	6	6.0
	Mourning warbler	0	0	0	0	0.0	0	0	2	0	0	0.4
	American redstart	0	0	0	0	0.0	2	0	0	0	0	0.4
Fringillidae	Rose-breasted grosbeak	2	2	2	0	1.5	0	0	2	0	2	0.8
	Chipping sparrow	0	0	0	0	0.0	1	0	0	0	0	0.2
	White-throated sparrow	0	1	0	0	0.3	2	0	0	0	2	0.8
Unidentified Birds		0	1	0	4	1.3	0	4	4	1	2	2.2
Total Birds		25	34	34	40	33.3	37	40	42	36	30	37.0

Table 7
Forest Bird Population Census
Ice Water Creek Research Area, Ontario
Site - 2
23-27 June, 1980

		Point census						Point census					
		May 26	May 27	May 28	May 29	May 30		May 29	May 29	May 29	May 29	May 29	
Family	Species	1	2	3	4	5	Avg	1	2	3	4	5	Avg
Cuculidae	Black-billed cuckoo	0	0	0	0	0	0.0	0	0	0	0	2	0.4
Picidae	Pileated woodpecker	0	0	0	0	2	0.4	0	0	0	0	0	0.0
Tyrannidae	Great crested flycatcher	0	0	2	2	0	0.8	0	2	0	2	2	1.2
	Eastern phoebe	0	0	2	0	0	0.4	0	0	0	2	0	0.4
Corvidae	Common vrow	2	0	0	0	0	0.4	0	0	1	0	0	0.2
Paridae	Black-capped vhickadee	0	0	2	0	2	0.8	0	0	0	0	0	0.0
Sittidae	Red-breasted nuthatch	2	2	0	0	2	1.2	0	0	4	2	4	2.0
Troglodytidae	Winter eren	4	4	2	2	2	2.8	2	2	4	2	0	2.0
Mimidae	Catbird	0	0	0	2	2	0.8	0	2	0	0	0	0.4
Turdidae	American robin	2	2	0	2	0	1.2	2	2	2	2	2	2.0
	Wood thrush	2	2	2	2	2	2.0	2	2	4	2	4	2.8
	Hermit thrush	4	4	2	0	2	2.4	2	0	2	0	0	0.8
	Swainson's thrush	2	0	2	0	0	0.8	0	0	0	0	0	0.0
	Veery	0	0	2	0	0	0.4	2	0	0	2	4	1.6
Parulidae	Parula warbler	4	4	2	0	4	2.8	0	0	4	2	2	1.6
	Black-throated green Warbler	0	0	0	0	0	0.0	0	0	0	0	2	0.4
	Blackburnian warbler	4	2	6	0	2	2.8	0	0	2	2	0	0.8

Table 7 (concluded)
Forest Bird Population Census
Ice Water Creek Research Area, Ontario
Site - 2
23-27 June, 1980

		Point census						Point census					
		May 26	May 27	May 28	May 29	May 30		May 29	May 29	May 29	May 29	May 29	
Family	Species	1	2	3	4	5	Avg	1	2	3	4	5	Avg
Parulidae	Chestnut-sided warbler	2	0	4	2	0	1.6	0	2	0	0	2	0.8
	Bay-breasted warbler	0	0	0	2	0	0.4	4	2	4	4	2	3.2
	Ovenbird	4	4	6	4	4	4.4	6	4	6	8	6	6.0
	Mourning warbler	0	0	0	0	0	0.0	0	0	2	0	0	0.4
	American redstart	0	0	0	0	0	0.0	0	0	2	2	2	1.2
Fringillidae	Rose-breasted grosbeak	2	6	4	2	2	3.2	0	2	2	2	0	1.2
	Chipping sparrow	0	0	0	2	0	0.4	0	2	0	0	0	0.4
	White-throated sparrow	0	2	2	2	2	1.6	0	2	2	2	4	2.0
Unidentified Birds		0	1	1	0	3	1.0	0	0	1	0	0	0.2
Total Birds		34	33	41	24	31	32.6	20	24	42	36	38	32.0

Table 8
Forest Bird Population Census
Ice Water Creek Research Area, Ontario
Site - 2
7-11 July, 1980

		Point census						Point census					
		July 7	July 8	July 9	July 10	July 11		July 10	July 10	July 10	July 10	July 10	
Family	Species	1	2	3	4	5	Avg	1	2	3	4	5	Avg
Tyrannidae	Great crested flycatcher	0	2	2	0	2	1.2	2	0	0	2	2	1.2
Corvidae	Blue jay	0	0	0	0	0	0.0	2	0	0	0	0	0.4
	Common raven	4	0	2	0	0	1.2	0	0	0	0	0	0.0
	Common crow	1	1	1	0	1	0.8	0	0	0	0	0	0.0
Sittidae	Red-breasted nuthatch	0	4	0	2	0	1.2	0	2	4	2	2	2.0
Troglodytidae	Winter wren	4	2	4	4	4	3.6	4	4	4	2	0	2.0
Mimidae	Catbird	0	2	0	0	0	0.4	0	0	0	0	0	0.0
Turdidae	American robin	0	0	0	3	3	0.8	2	2	2	0	0	1.2
	Wood thrush	4	2	2	2	4	2.8	2	2	4	6	4	2.6
	Hermit thrush	0	0	0	0	0	0.0	0	0	0	0	2	0.4
	Swainson's thrush	0	2	0	0	0	0.4	0	0	0	0	2	0.4
	Veery	0	0	0	0	4	0.8	2	0	0	0	2	0.8
Parulidae	Blackburnian warbler	0	0	0	0	0	0.0	0	0	2	0	0	0.4
	Bay-breasted warbler	4	4	4	0	2	2.8	2	0	2	4	0	1.6
	Ovenbird	10	8	10	6	8	8.4	10	6	10	12	6	8.8
	Mourning warbler	0	0	2	0	0	0.4	0	0	0	0	0	0.0
Fringillidae	Rose-breasted grosbeak	0	2	2	2	0	1.2	2	2	0	0	0	0.0
	Chipping sparrow	2	0	2	0	0	0.8	0	0	0	0	0	0.0
	White-throated sparrow	2	2	4	4	0	2.4	0	4	4	6	2	3.2
	Song sparrow	2	0	0	0	0	0.4	0	0	0	0	0	0.0
Unidentified Birds		0	0	2	0	1	0.6	0	0	1	1	1	0.6
Total Birds		38	31	37	22	28	30.2	28	22	33	35	23	28.2

Table 9
Forest Bird Population Census
Ice Water Creek Research Area, Ontario
Site - 3
26-30 May, 1980

		Point census						Point census					
		May 26	May 27	May 28	May 29	May 30		May 29	May 29	May 29	May 29	May 29	
Family	Species	1	2	3	4	5	Avg	1	2	3	4	5	Avg
Gaviidae	Common loon	0	2	0	0	0	0.4	0	0	0	0	0	0.0
Anatidae	Red-breasted merganser	0	0	0	0	0	0.0	0	0	1	0	0	0.2
Apodidae	Chimney swift	0	0	1	0	5	1.2	0	0	0	0	0	0.0
Alcedinidae	Belted kingfisher	0	0	2	0	0	0.4	0	0	0	0	0	0.0
Picidae	Hairy woodpecker	0	0	0	0	2	0.4	0	0	0	2	0	0.4
Tyrannidae	Eastern kingbird	0	0	0	0	2	0.4	0	0	0	0	0	0.0
	Great crested flycatcher	0	2	0	2	0	0.8	2	2	2	2	0	1.6
	Alder flycatcher	0	0	0	0	0	0.0	0	2	2	6	4	2.8
	Least flycatcher	0	2	2	0	0	0.8	0	2	2	2	2	1.6
	Eastern wood peewee	0	0	0	0	0	0.0	0	2	0	0	0	0.4
	Olive-sided flycatcher	0	0	0	2	2	0.8	2	2	0	2	0	1.2
Corvidae	Blue jay	0	0	0	0	0	0.0	0	2	0	0	0	0.4
	Common crow	0	2	0	0	1	0.6	0	0	0	0	0	0.0
Paridae	Black-capped chickadee	0	0	0	0	6	1.2	0	0	0	0	0	0.0
Sittidae	Red-breasted nuthatch	2	2	0	0	2	1.2	0	0	0	0	2	0.4
Mimidae	Catbird	0	0	0	0	2	0.4	0	2	0	0	0	0.4

Table 9 (concluded)
Forest Bird Population Census
Ice Water Creek Research Area, Ontario
Site - 3
26-30 May, 1980

		Point census						Point census					
		May 26	May 27	May 28	May 29	May 30		May 29	May 29	May 29	May 29	May 29	
Family	Species	1	2	3	4	5	Avg	1	2	3	4	5	Avg
Turdidae	American robin	0	4	1	2	2	1.8	2	0	0	3	0	1.0
	Wood thrush	0	2	4	0	2	1.6	0	4	0	2	0	1.2
	Hermit thrush	0	4	0	0	2	1.2	0	0	0	0	0	0.0
	Swainson's thrush	0	2	0	2	2	1.2	2	2	4	2	0	2.0
Bombycillidae	Cedar waxwing	0	0	0	0	4	0.8	0	2	0	5	0	1.4
Vireonidae	Red-eyed vireo	0	0	0	0	2	0.4	0	2	2	2	2	1.6
Parulidae	Black-and-white warbler	0	2	0	0	2	0.8	0	0	0	0	0	0.0
	Tennessee warbler	0	0	0	0	2	0.4	0	0	0	0	0	0.0
	Nashville warbler	2	2	4	4	0	2.4	4	6	6	4	4	4.8
	Chestnut-sided warbler	2	4	8	4	10	5.6	4	6	6	4	6	5.2
	Northern waterthrush	0	2	0	0	0	0.4	0	0	0	0	2	0.4
	Common yellowthroat	2	4	2	4	4	3.2	4	8	4	4	6	5.2
	American redstart	2	6	0	0	2	2.0	0	0	0	2	0	0.4
Fringillidae	Rose-breasted grosbeak	2	2	4	4	2	2.8	4	4	4	0	4	3.2
	American goldfinch	0	0	0	1	2	0.6	1	0	2	0	0	0.6
	White-throated sparrow	0	6	8	4	8	5.2	4	8	3	6	6	5.4
	Song sparrow	0	0	0	2	0	0.4	2	0	0	3	0	1.0
Total Birds		14	50	38	31	68	40.2	31	56	38	51	38	42.8

Table 10
Forest Bird Population Census
Ice Water Creek Research Area, Ontario
Site - 3
9 - 12 June, 1980

		Point Census					Point Census					
		June 9	June 10	June 11	June 12		June 12	June 12	June 12	June 12	June 12	
Family	Species	1	2	3	4	Avg	1	2	3	4	5	Avg
Anatidae	Red-breasted merganser	0	0	1	0	0.3	0	0	0	0	0	0.0
Accipitridae	Broad-winged hawk	0	0	0	0	0.0	0	0	0	0	1	0.2
Apodidae	Chimney swift	0	0	0	0	0.0	0	0	1	0	0	0.2
Alcedinidae	Belted kingfisher	0	0	0	2	0.5	1	2	0	2	0	1.0
Picidae	Common flicker	0	2	0	0	0.5	0	0	0	0	0	0.0
	Hairy woodpecker	0	0	0	0	0.0	0	0	2	0	0	0.4
Tyrannidae	Great crested flycatcher	0	0	0	2	0.5	0	2	4	0	0	1.2
	Alder flycatcher	0	2	4	2	2.0	2	2	2	2	2	2.0
	Olive-sided flycatcher	0	0	0	0	0.0	0	0	0	2	2	0.8
	Least flycatcher	0	0	2	0	0.5	0	0	0	0	0	0.0
Hirundinidae	Tree swallow	0	0	1	0	0.3	0	0	0	0	0	0.0
Turdidae	American robin	0	2	0	5	1.8	0	5	1	4	1	2.2
	Wood thrush	0	0	2	0	0.5	0	0	0	0	0	0.0
	Hermit thrush	0	2	0	0	0.5	0	0	0	0	0	0.0
	Swainson's thrush	0	0	0	0	0.0	0	0	2	2	2	1.2
	Veery	0	0	0	0	0.0	0	0	4	0	0	0.8
Bombycillidae	Cedar waxwing	0	2	2	6	2.5	1	6	2	0	0	1.8
Vireonidae	Red-eyed vireo	2	0	2	0	1.0	2	0	2	2	2	1.6

Table 10 (concluded)
Forest Bird Population Census
Ice Water Creek Research Area, Ontario
Site - 3
9 - 12 June, 1980

		Point Census					Point Census					
		June 9	June 10	June 11	June 12		June 12	June 12	June 12	June 12	June 12	
Family	Species	1	2	3	4	Avg	1	2	3	4	5	Avg
Parulidae	Black-and-white warbler	0	0	0	4	1.0	2	4	2	4	2	2.8
	Tennessee warbler	0	0	0	2	0.5	0	2	0	0	0	0.4
	Nashville warbler	2	2	2	4	2.5	0	4	0	4	0	1.6
	Yellow warbler	0	0	0	2	0.5	0	2	0	0	0	0.4
	Magnolia warbler	2	0	0	0	0.5	0	0	2	0	0	0.4
	Yellow-rumped warbler	0	0	2	1	0.8	0	1	1	1	0	0.6
	Chestnut-sided warbler	6	8	4	6	6.0	4	6	6	4	4	4.8
	Mourning warbler	2	2	0	2	1.5	4	2	2	4	2	2.8
	Common yellowthroat	0	6	2	8	4.0	0	8	2	0	0	2.0
	Canada warbler	0	0	0	2	0.5	0	2	0	0	0	0.4
	American redstart	0	0	0	3	0.8	0	3	4	4	2	2.4
Fringillidae	Rose-breasted grosbeak	4	4	0	2	2.5	0	2	2	2	0	1.2
	American goldfinch	0	0	0	0	0.0	0	0	0	5	0	1.0
	White-throated sparrow	0	8	4	6	4.5	6	7	4	6	6	5.6
	Song sparrow	2	0	2	4	2.0	0	4	2	2	2	2.0
Total Birds		20	40	30	63	38.3	22	64	47	50	28	41.8

Table 11
Forest Bird Population Census
Ice Water Creek Research Area, Ontario
Site - 3
23-27 June, 1980

		Point census						Point census					
		June 7	June 8	June 9	June 10	June 11		June 10	June 10	June 10	June 10	June 10	
Family	Species	1	2	3	4	5	Avg	1	2	3	4	5	Avg
Anatidae	Red-breasted merganser	0	1	0	1	1	0.6	0	1	0	1	0	0.4
Alcedinidae	Belted kingfisher	1	0	0	2	0	0.6	0	2	0	0	0	0.4
Picidae	Common flicker	0	0	0	0	0	0.0	0	0	0	0	2	0.4
Tyrannidae	Great crested flycatcher	2	2	4	0	0	1.6	0	0	0	0	0	0.0
	Alder flycatcher	2	2	0	0	2	1.2	2	0	2	2	2	1.6
	Least flycatcher	2	0	0	0	0	0.4	0	0	0	2	0	0.4
	Olive-sided flycatcher	2	2	0	0	2	1.2	0	0	2	2	2	1.2
Corvidae	Common raven	1	0	0	0	0	0.2	0	0	0	0	0	0.0
Sittidae	Red-breasted nuthatch	0	0	0	0	0	0.0	0	0	0	1	2	0.6
Troglodytidae	winter wren	0	2	2	2	0	1.2	2	2	0	0	0	0.8
Mimidae	Catbird	0	2	0	0	0	0.4	0	0	0	0	0	0.0
Turdidae	American robin	0	0	0	0	1	0.2	0	0	2	2	0	0.8
	Swainson's thrush	2	2	0	0	0	0.8	2	0	2	0	0	0.8
	Veery	2	2	4	0	2	2.0	4	0	2	0	0	1.2
Vireonidae	Red-eyed vireo	2	2	4	2	0	2.0	0	2	2	2	4	2.0

Table 11 (concluded)
Forest Bird Population Census
Ice Water Creek Research Area, Ontario
Site - 3
23-27 June, 1980

		Point census						Point census					
		June 7	June 8	June 9	June 10	June 11		June 10	June 10	June 10	June 10	June 10	
Family	Species	1	2	3	4	5	Avg	1	2	3	4	5	Avg
Parulidae	Black-and-white warbler	2	0	0	2	2	1.2	2	2	0	0	4	1.6
	Tennessee warbler	2	2	0	2	2	1.6	2	2	2	2	0	1.6
	Nashville warbler	0	2	2	0	0	0.8	2	0	0	0	0	0.4
	Black-throated green warbler	0	0	0	0	0	0.0	0	0	0	2	2	0.8
	Chestnut-sided warbler	4	4	6	4	8	5.2	4	4	6	4	4	4.4
	Mourning warbler	2	2	2	2	2	2.0	2	2	2	2	0	1.6
	Common yellowthroat	2	4	2	2	2	2.4	0	2	2	2	2	1.6
	American redstart	2	2	2	2	2	2.0	4	2	6	6	4	4.4
Fringillidae	Rose-breasted grosbeak	2	2	2	2	2	2.0	2	2	0	2	0	1.2
	White-throated sparrow	4	4	4	6	8	5.2	4	6	5	8	8	6.2
	Song sparrow	2	0	2	2	2	1.6	2	2	2	2	4	2.4
Unidentified Birds		0	0	2	0	0	0.4						
Total Birds		38	39	38	31	38	36.8	34	31	37	42	40	36.8

Table 12
Forest Bird Population Census
Ice Water Creek Research Area, Ontario
Site - 3
7-11 July, 1980

		Point census						Point census					
		July 7	July 8	July 9	July 10	July 11		July 10	July 10	July 10	July 10	July 10	
Family	Species	1	2	3	4	5	Avg	1	2	3	4	5	Avg
Picidae	Common flicker	0	0	4	2	0	1.2	0	2	0	2	0	0.8
	Yellow-bellied sapsucker	0	0	0	0	0	0.0	0	0	2	0	0	0.4
Tyrannidae	Great crested flycatcher	2	0	2	0	0	0.8	0	0	0	0	0	0.0
	Alder flycatcher	2	0	0	0	0	0.4	0	0	0	0	0	0.0
	Olive-sided flycatcher	2	2	0	0	2	1.2	2	0	0	0	2	0.8
Corvidae	Gray jay	0	0	0	0	0	0.0	0	0	0	0	2	0.4
	Common crow	0	0	1	0	0	0.2	0	0	0	0	0	0.0
Paridae	Black-capped chickadee	2	0	0	0	0	0.4	0	0	0	2	0	0.4
Troglodytidae	Winter wren	0	4	0	2	2	1.6	2	2	0	0	2	1.2
Mimidae	Catbird	0	0	0	0	0	0.0	2	0	0	0	0	0.4
Turdidae	American robin	2	0	4	0	0	1.2	0	0	0	2	2	0.8
	Wood thrush	0	2	0	2	2	1.2	2	2	2	0	0	1.2
	Swainson's thrush	0	0	0	0	0	0.0	0	0	0	0	2	0.4
	Veery	2	2	0	4	4	2.4	2	4	0	4	0	2.0
Bombycillidae	Cedar waxwing	1	0	0	0	0	0.2	0	0	0	0	0	0.0
Vireonidae	Red-eyed vireo	0	0	2	2	2	1.2	2	2	4	2	2	2.4

Table 12 (concluded)
Forest Bird Population Census
Ice Water Creek Research Area, Ontario
Site - 3
7-11 July, 1980

		Point census						Point census					
		July 7	July 8	July 9	July 10	July 11		July 10	July 10	July 10	July 10	July 10	
Family	Species	1	2	3	4	5	Avg	1	2	3	4	5	Avg
Parulidae	Black-and-white warbler	0	0	2	0	0	0.4	0	0	0	2	0	0.4
	Tennessee warbler	0	2	0	0	0	0.4	0	0	0	0	0	0.0
	Nashville warbler	0	0	0	2	0	0.4	0	2	2	0	0	0.8
	Chestnut-sided warbler	4	2	2	3	0	2.2	0	3	4	3	0	2.0
	Mourning warbler	2	2	0	2	2	1.6	2	2	2	2	2	2.0
	Common yellowthroat	2	0	2	2	0	1.2	2	2	0	2	2	1.6
	American redstart	2	0	2	0	0	0.8	0	0	0	0	0	0.0
Fringillidae	Rose-breasted grosbeak	2	2	2	0	2	1.6	0	0	0	0	0	0.0
	Purple finch	0	0	2	0	0	0.4	0	0	0	0	0	0.0
	White-throated sparrow	2	6	2	4	4	3.6	4	4	6	10	6	6.0
	Song sparrow	0	2	0	0	4	1.2	0	0	2	2	4	1.6
Unidentified Birds		1	0	1	0	0	0.4	0	0	0	0	0	0.0
Total Birds		28	26	28	25	24	26.2	20	25	24	33	26	25.6